THE

PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES

FOR THE YEAR

1928

VOL. LIII.

WITH THIRTY-NINE PLATES, ONE PORTRAIT
and 173 Text-figures

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CORRIGENDA.

Page 14, line 22, for *Tyramorphus*, read *Tyromorphus*
Page 35, line 39, for *australe*, read *australis*
Page 101, line 40, for *sinuatifscia*, read *sinuatifascia*
Page 336, line 28, for *Prasophylum*, read *Prasophyllum*
Page 526, line 2, *for* larger, *read* smaller
Page 521, line 8 } *for* placenta
Page 533, in column "Megasporogenesis" } *or* placental
Page 538, explanation of Plate xxxv, Figs. 23, 28 } *read* receptacle.
Page 601, line 7, for *Calloplatyura* read *Calliplatyura* (Note: *Calliplatyura* takes precedence, appearing in the key on Page 600)

THE

PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES

WEDNESDAY, 28TH MARCH, 1928.

The Fifty-third Annual General Meeting, was held at Macleay House, 16 College Street, Sydney, on Wednesday evening, 28th March, 1928.

ANNUAL GENERAL MEETING.

Mr. R. H. Cambage, C.B.E., F.L.S., Vice-President, in the Chair.

The minutes of the preceding Annual General Meeting (30th March, 1927) were read and confirmed.

CHAIRMAN'S ADDRESS.

A sad and melancholy circumstance is responsible for the delivery of a Presidential Address to-night when the Society has no President. It was characteristic of the enthusiasm and thoroughness of Professor Harrison that he had completed the manuscript of his Address nearly three months before the time for its delivery and so we are able to listen to his able summary of his own work in connection with some important problems concerning host and parasite.

For the second time in the history of the Society death has snatched a President before the completion of his term of office. In November, 1890, some nine weeks before the Annual Meeting, Professor W. J. Stephens, President of the Society, died after a short severe illness; this year, some five weeks before this Annual Meeting, we were all appalled by the news of the sudden death of Professor L. Harrison whilst enjoying a well-earned holiday at Narooma. The parallelism of the two losses is strikingly close; each occupied a professorship of Natural History, Professor Stephens having the wider designation of Professor of Natural History, Professor Harrison the more specialized one of Professor of Zoology; each had made extremely valuable contributions to Australian Natural History; each had served this Society with distinction in the office of President; and each was revered and beloved by colleagues and friends. It is a remarkable fact that during a short period of three years, seven deaths have occurred of members who have occupied our Presidential Chair—mere contemplation of their names makes us realize our losses: Haswell, Steel, Maiden, Fletcher, Hedley, Ferguson, Harrison.

In March, 1927, Mr. M. F. Albert, who had purchased from the Society the land on which stood the Linnean Hall at Elizabeth Bay, approached the Council

with the object of obtaining possession of the land before the Society's lease expired in November, 1928. His proposals were accepted by the Council and arrangements were made to house the Society's library at the Macleay Museum and to store the bacteriologist's apparatus and equipment. On 25th May, 1927, the property was formally handed over to Mr. Albert, the Society thus finally relinquishing all title to the land which Sir William Macleay presented to it in October, 1885, for the unexpired balance (about 89 years) of his original lease, and of which the Society purchased the freehold about the end of 1910.

For some time past the possibility of providing a building in which most, if not all, of the scientific societies of Sydney could be housed has been under consideration by a committee composed of representatives of the Institution of Engineers, the Royal Society of New South Wales and our Society. As a first step representations were made to the Government of New South Wales, which has expressed its willingness to provide a site and has offered a piece of land at the corner of Essex and Gloucester Streets. A practicable proposal appears to have been put forward, but negotiations have not yet approached the final stages. In the meantime the Society's library remains at the Macleay Museum, and until some final decision has been arrived at, your Council will not further consider the plan which it had in view of providing a new building for a hall and library at 16 College Street.

The nineteenth meeting of the Australasian Association for the Advancement of Science was held at Hobart in January last and proved highly successful, indicating that the good done by the meetings is appreciated both by the public and by scientific workers. Each of the fifteen sections of the Association held well attended meetings and was fully occupied with papers and discussions.

About June, 1927, the Government of New South Wales issued a proclamation protecting, for a period of one year, certain of the wild flowers. The Government is to be congratulated on taking this step; it is, however, only a step towards giving our beautiful flowers an opportunity to recover from the many years of unrestrained picking to which they have been subject, and it is to be hoped not only that the period of protection will be extended but that, as necessity arises, the protection will be extended to other species that may be in danger of extermination.

The concluding part of Volume lii of the Society's Proceedings has been issued. The complete volume (571 plus xcv pages, 50 plates and 372 text-figures) contains thirty-seven papers from twenty-six authors, five of the papers being contributions from the Society's research staff. In view of the fact that for the last two years there has been a big accumulation of papers towards the end of the year, as a result of which a number have had to be held over till the following year's Proceedings, the Council has decided to increase the size of the volume by the issue of an additional part each year. There will now be four parts devoted to the publication of papers, the months of issue being probably May, July, October and December. In this way the Council hopes to keep abreast of the increasing activity of members of the Society.

The addition to Rule vi, agreed to and confirmed at Special General Meetings on 30th March and 27th April, 1927, makes provision for Life Membership of the Society which may be taken advantage of by members who wish to compound their annual subscription.

Exchange relations with scientific societies and institutions have continued to be normal. The number of receipts for the session shows a large increase due,

in part, to the resumption of exchanges with some Russian societies and to the receipt of some long series of periodicals in exchange for the Proceedings. The receipts total 2,540 as compared with 1821, 1409 and 1457 for previous sessions. Applications for the establishment of exchange relations continue and during the past twelve months the following societies and institutions have been added to our exchange list:—Department of Mines, Adelaide; Mines Department, Hobart; Geological Survey of the Netherlands East Indies, Bandoeng, Java; Musée Royale d'Histoire Naturelle, Brussels; Agricultural Experiment Station, Stockholm; Société des Naturalistes de Kiew, Kiew; State Institute of Experimental Agronomy, Bureau of Applied Entomology, Leningrad; Kossino Biological Station, Moscow; Agricultural Experiment Station, Saratov; Société Entomologique de Stavropol, Stavropol; San Diego Society of Natural History, San Diego. One exchange—with the American Entomological Society—has been discontinued.

The vacancy on the Council caused by the death of Dr. E. W. Ferguson was filled by the election of Mr. A. J. Nicholson, M.Sc.

I have much pleasure in offering the Society's heartiest congratulations to:—

Mr. E. C. Andrews on his election as President-elect of the Australasian Association for the Advancement of Science; Dr. W. G. Woolnough on his appointment as Geological Adviser to the Commonwealth Government; Mr. A. H. K. Petrie on his election to an 1851 Exhibition Travelling Scholarship; Dr. R. J. Tillyard on his appointment as Chief Commonwealth Entomologist; Mr. C. A. Sussmilch on his appointment as Principal of the East Sydney Technical School and Assistant Superintendent of Technical Education; Mr. C. Barnard on his appointment as Assistant Botanist to the Council for Scientific and Industrial Research; Professor T. G. B. Osborn on his appointment to the Chair of Botany in the University of Sydney; Sir Douglas Mawson on the award to him of the medal of the Société de Géographie, Paris, in recognition of the oceanographical work of the Australasian Antarctic Expedition.

During the past year the names of sixteen members have been added to the list and four names have been removed, two members have resigned and death has taken five members. The number of ordinary members now on the roll is 168. The losses by death have again been very severe, the names being D. F. Cooksey, E. W. Ferguson, L. Harrison, John Mitchell and R. Greig Smith.

In addition to these, four former members have died during the year, viz.: Professor A. Liversidge, an original member who continued his membership till 1907, Messrs. E. R. Waite and T. Whitelegge, both of whom had been members of Council, and Dr. J. M. Petrie, Linnean Macleay Fellow in Biochemistry from 1907 to 1925. Mr. Waite was a member of the Society from 1893 to 1914 and a Councillor from 1904 to 1906; Mr. Whitelegge was elected a member in 1883 and served on the Council from 1890 to 1896.

Daniel Frederick Cooksey, who died on 16th September, 1927, after a short illness, was born in London on 10th June, 1864. With his wife and family he came to Australia about seventeen years ago, residing in Victoria for nearly three years. He then came to Sydney and afterwards removed to Mayfield, Newcastle. For the past five years he had been employed in the drawing office of the Broken Hill Proprietary Company in Newcastle. He joined this Society in 1926 but as his residence was so far away he was able to attend few meetings. Whilst in Newcastle he took a keen interest in relics of the aboriginals and being an assiduous collector, he had gathered together a very large number of aboriginal implements and had carefully mapped the areas in the Newcastle District where

they occurred. He was a man of some artistic ability and achievement, having studied decorative art in his younger days.

EUSTACE WILLIAM FERGUSON, son of the late Rev. John Ferguson, was born at Invercargill, New Zealand, in 1884, and came to Sydney in 1894. He received his early education at various schools in Sydney and entered the University in 1903. In 1908 he graduated M.B., Ch.M., with honours, having, during his course, won Professor Haswell's prize for Zoology, the Collie prize for Botany and Professor Anderson's prize for Logic. After graduation he was appointed Resident Medical Officer at Sydney Hospital, and during 1909-10 he served as Pathologist to the Hospital.

In 1911 he went into private practice with Dr. Walton Smith, but after a short time he entered the Public Service, being appointed, in 1912, a medical officer at the Rydalmere Hospital for the Insane. In 1913 he was transferred to the Microbiological Laboratory of the Department of Public Health but soon afterwards (in 1915) he volunteered for service overseas during the Great War and was for four years attached to the Australian Army Medical Corps in England, France and Palestine. He was for some time in charge of the Anzac Field Laboratory in the Jordan Valley. In 1920, shortly after resuming his work at the Health Department, he was appointed Principal Microbiologist in succession to Dr. J. B. Cleland, who had been appointed to the Chair of Pathology in the University of Adelaide. He was taken ill on 27th November, 1926, and after suffering severely from Bright's disease for nearly eight months, he died on 18th July, 1927.

Early in life he evinced a keen interest in entomology and whilst an undergraduate succeeded in collecting many rare beetles on the Blue Mountains and around Sydney. He retained this interest for the remainder of his life, studying particularly a family of ground-weevils (Amycteridae) on which he contributed a series of ten papers to our Proceedings during the years 1909 to 1923, in addition to one paper dealing with the Amycteridae of the Voyage of the Astrolabe, 1835, in 1911. He also combined his entomological interests with his medical work and in this connection became an authority on Australian flies and mosquitoes, and one of the outstanding authorities of his day on medical entomology. He had a very wide knowledge of insects in general, but confined his published original work to a few special groups. His contribution to the study of other groups, however, was no mean one, for he collected widely and submitted many of his collections to other specialists who studied them and published the results of their study. Amongst such may be mentioned the series of Studies on Australian Diptera in our Proceedings, by J. R. Malloch; a large proportion of the material there described was forwarded to Mr. Malloch by Eustace Ferguson. He was a gifted collector, his keen eye and unusually developed powers of close observation making possible for him what would have been impossible for many, namely the collection of groups of insects, so minute in size and so swift in flight that their capture is a matter of no little difficulty. He had also a wide knowledge of Australian birds and often astonished his colleagues by his familiarity with birds which he met for the first time, having previously only known them from books.

He joined our Society in 1908, was elected a member of Council in 1921 and was President for the Session 1926-1927. He was a member of the Royal Society of New South Wales and a Councillor of the Royal Zoological Society of New South Wales, of which he was President for the year 1922-23. He was also a Fellow of the Royal Institute of Tropical Medicine. In addition to his eleven papers on Amycteridae he contributed to our Proceedings one on a new species

of Mycetophilidae and three (in conjunction with colleagues) on Australian Tabanidae.

Robert Greig-Smith, who died at Darlinghurst on 6th August, 1927, was born at Edinburgh in 1866. He was educated at George Watson's College and in 1890 obtained the degree of Bachelor of Science at the University of Edinburgh, where he had a distinguished course, especially in botany and chemistry. In 1891 he was appointed Lecturer in Agricultural Chemistry at the Durham College of Science at Newcastle-upon-Tyne where, later, by vote of convocation he was awarded the degree of M.Sc. Whilst he was at Durham College he was additional examiner in Agricultural Chemistry in the University of Edinburgh and also in Chemistry and Physics to the Highland and Agricultural Society of Scotland. He obtained continental experience in his subject by studying in the laboratories of Professor Stutzer of Bonn, and Herr Alfred Jorgensen of Copenhagen. He was appointed Macleay Bacteriologist to this Society at a special meeting of Council on 4th March, 1898, and arrived in Sydney in September of the same year, taking up his duties immediately. The fitting up of a laboratory, which had been delayed until his arrival, took some time but it was not long before he was able to settle down to his research, his first paper appearing in Part 4 of the Proceedings for 1899. During the twenty-nine years for which he was Macleay Bacteriologist he contributed 81 papers to the Proceedings, covering a wide range of bacteriological problems, amongst which may be noted those dealing with the Bacterial Flora of the Sydney Water Supply (1900), the Bacterial Origin of Gums of the Arabin Group (1902-04), Contributions to our Knowledge of Soil Fertility (1910-18), the Germicidal Activity of Eucalyptus Oils (1919), the High Temperature Organism of Fermenting Tan-bark (1921-23), the Influence of Colloids upon Fermentation (1924-27), and numerous smaller papers dealing with Slime Bacteria, and the Formation of Slime, and also the Fixation of Nitrogen. In 1903 he attained his doctorate in Science of the University of Edinburgh.

Apart from his research work he took a keen interest in scientific societies whose range of work covered his own subject, and held office in a number of them. In 1906 he was President of the Pathological Club of Sydney; 1907, President of Section I of the Australasian Association for the Advancement of Science; 1906-08, Chairman of the Sydney Section of the Society of Chemical Industry; 1915, President, 1925-27, Hon. Secretary, and 1906-1927, member of Council of the Royal Society of New South Wales.

During his term of office he was twice granted extended leave to enable him to visit Europe to keep in touch with the progress of bacteriological work by establishing personal contact with colleagues working on subjects similar to his own. He became ill in the early part of 1927 and the Council granted him six months' leave in the hope that the rest would enable him to recover but he passed away quietly on 6th August. He leaves behind him a large bulk of research in bacteriology which cannot but be of considerable value to future workers in a subject in which at the present time there are far too few research workers in Australia.

Launcelot Harrison, the eldest son of the late Dr. Thomas Harrison, of Sydney, was born at Wellington, N.S.W., in 1880. He was educated at the King's School, Parramatta, where he was head of the school and Broughton Scholar for two years.

In 1911 he entered the University of Sydney and in 1913 graduated Bachelor of Science with first-class Honours and the University Medal in Zoology and Honours in Botany. He won Professor Haswell's prize for Zoology and Mr.

W. S. Dun's prize for palaeontology during his course. During 1913 and 1914 he was Junior Demonstrator in Zoology and Botany and in 1914 was awarded the John Coutts Scholarship. In the same year he was elected to an 1851 Exhibition Scholarship and proceeded to Cambridge where he won an exhibition for research at Emmanuel College. In 1916 he gained the degree of Bachelor of Arts (Research), Cambridge. He did a large amount of scientific work in connection with the Great War, working for about fifteen months in the laboratory under Professor Nuttall and in 1916 he went as Advisory Entomologist to the Expeditionary Force in Mesopotamia with the rank of Lieutenant, later being promoted to Captain. The work accomplished in preventing the communication and spread of insect-carried diseases was of the greatest importance and undoubtedly saved a large number of valuable lives. While still on active service he was appointed Lecturer and Demonstrator in Zoology in the University of Sydney in 1918, the position being held for him until he resumed duty in July, 1919. In September, 1920, he was appointed Acting Professor of Zoology and in 1923 became Professor of Zoology, succeeding the late Professor S. J. Johnston. In 1920, he was also appointed Lecturer in Veterinary Parasitology. He took the keenest interest in University affairs apart from his own subject and was President of the Union in 1920-21, and held office in the University Science Society and University Dramatic Society.

While he was at Cambridge he took an active interest in University life and in scientific matters; he was a Vice-President of the Cambridge Union Society and President of the Cambridge Natural History Society. In 1915 he was invited to open a discussion before Section D (Zoology) of the British Association on the general question of host-parasite relations, and in the following year to address the British Ornithologists' Club, when he propounded a classification of petrels based entirely upon their Mallophagan parasites.

For many years before he entered the University he was interested in Natural History and was an active member of the Field Naturalists' Club. He was interested in his earlier life especially in external parasites—the Mallophaga in particular—and in birds, but later he had the widest possible interest in general zoology, though perhaps the subject of the relation between host and parasite, in its many aspects, held first place with him till the end.

During the last year or two he was specially interested in the evidence contributed by host-parasite occurrences to the solution of problems of former land connections, particularly between Australia, Antarctica, and South America and made this the subject of a fine address to Section D of the Australasian Association for the Advancement of Science at Perth in August, 1926. Harrison had all the attributes which go to make a successful University Professor in the widest sense, amongst them a thorough knowledge of his subject and the capacity for imparting that knowledge to others, ability of the highest order for carrying out research, combined with the rare faculty of inspiring and stimulating research in his students, and finally the possession of administrative ability far above the average. He has left his mark on Australian Zoology, not only in his wide accomplishment in research but also in an enthusiastic group of students who have done much research already and give promise of attaining high places among Australian zoologists.

His published work, chiefly on Mallophaga and the relations between host and parasite, is scattered widely in scientific journals; he contributed papers at various times to *The American Naturalist*, *Parasitology*, *The Ibis*, *The Proceedings*

of the Cambridge Philosophical Society, and *The Report of the British Association for the Advancement of Science*, in addition to many of the Australian scientific societies. To our Proceedings he contributed only four papers, two of them in conjunction with colleagues.

JOHN MITCHELL, who died on 14th January, 1928, at the War Memorial Hospital, Waverley, Sydney, after having undergone an operation the previous day, was born at Ballieston, near Glasgow, Scotland, in 1848, and came to Australia a year later with his parents, who settled in the Newcastle District, his father having been appointed Under Manager for the Coal and Copper Company's mine at Victoria Tunnel, Glebe, Newcastle. In 1873 he joined the Department of Public Instruction and received his training at the Fort Street Training School. After teaching for a short time in the Newcastle district he was transferred to Balranald, where he remained for nine years and in 1883 he was moved to Bowning. In 1898 he was appointed to take charge of the Technical College and School of Mines at Newcastle where he remained until his retirement about sixteen years later. Besides administering the affairs of the College, he lectured on a wide range of subjects including Geology, Mineralogy, Chemistry, Assaying and Botany. In 1910 he visited Europe, visiting a number of Technical Colleges and also accompanied the late Sir George Reid to an educational conference in Belgium.

He was a gifted collector, and his collecting days commenced at Balranald where he gathered together a collection of beetles and butterflies. But on his removal to Bowning, a district rich in geological and palaeontological interest, he commenced to turn his attention seriously to Geology and occupied all his spare time in collecting fossils. Spending many years in a locality so rich in fossils he soon amassed a fine collection, which he studied seriously, the results of his studies being published in a series of valuable papers in our Proceedings. His published work was chiefly confined to the two groups Trilobita and Brachiopoda, though in addition he contributed occasional papers on Gasteropods, Pelecypods and more recently he turned his attention to *Leaia* and the Estheriae. It was on the Trilobites and Brachiopods, however, that his best work was done and on which he was regarded as an authority. On the Trilobites he worked for many years in collaboration with the late R. Etheridge, Jr., and together they published a series of seven important papers in these Proceedings between the years 1890 and 1917. His own papers in the Proceedings numbered seventeen between the years 1886 and 1927, his last paper having been published after he attained the age of 79 years and less than a year before his death.

After his retirement he lived at Waratah in the Newcastle district, and devoted a great deal of time to the collection of fossil insects in the Newcastle Coal Measures. These fossils are not plentiful and a keen eye was necessary for their discovery, but with the born collector's instinct and patience he managed to gather a fine collection; he also had extensive collections of fossil plants, particularly from the Wianamatta Shales in the vicinity of Narellan and Glenlee and from the *Glossopteris*-bearing rocks of the Newcastle district.

The year's work of the Society's research staff may be summarized thus:

The late Dr. R. Greig-Smith, Macleay Bacteriologist to the Society, continued his investigations into the activity of mineral colloids upon fermentation; a paper containing three further parts of this work appeared in the PROCEEDINGS for 1927. Having been in indifferent health for some time he was, in May, 1927, granted six months leave of absence in the hope that he would regain his normal health, but his illness was terminated suddenly by his death on 6th August, 1927.

Dr. I. M. Mackerras, Linnean Macleay Fellow of the Society in Zoology, was given leave of absence in January, 1927, to carry on work at the Bureau of Microbiology during the absence of Dr. E. W. Ferguson. After Dr. Ferguson's lamentable death, Dr. Mackerras was offered a permanent appointment which he accepted and resigned his Fellowship on 30th September. Actually then he did not carry out any research as a Linnean Macleay Fellow during the past year, but he submitted two papers on mosquitoes containing the results of his previous year's research as a Fellow and these appear in the PROCEEDINGS for 1927.

Miss May M. Williams, Linnean Macleay Fellow of the Society in Botany, has continued her observations on the gametogenesis and life-history of *Bryopsis plumosa*. She was successful in obtaining fertilization of the female gamete and germination of the zygospore thus formed, and was able to study the various stages in detail. She also commenced a study of *Ectocarpus*, spending some time on the literature relating to this and allied genera, having in view an investigation of the formation of unilocular and multilocular sporangia.

Miss Ida A. Brown, Linnean Macleay Fellow of the Society in Geology, spent the earlier part of the year in the laboratory, working on specimens collected previously in the Moruya district and on the preparation of her geological map. She then spent some time in the district in order to complete the mapping, and studied in particular the relationships of the Early Palaeozoic sediments and the occurrence of the Tertiary beds. Further field work was done in the Tilba-Mt. Dromedary area, to the south of Milton, where she did some preliminary mapping and collecting. Part of the work on the Moruya district dealing with the Palaeozoic geology has now been completed and the results embodied in a paper which will appear in the PROCEEDINGS for 1928. A further paper on the Cainozoic geology of the area is to form a later part of the work.

Miss Brown proposes this year to continue the work on the geological history of the South Coast of New South Wales, paying special attention to the problems of the geological age, conditions of sedimentation, mutual relationships and subsequent tectonic history of the sedimentary rocks, and the relationships, petrogenesis and correlation of the associated igneous rocks, south of Moruya.

Miss H. Claire Weekes, Linnean Macleay Fellow of the Society in Zoology, commenced her work by studying four species of scincid lizards, her results being included in a paper, "A note on reproductive phenomena in some Lizards", which appeared in the PROCEEDINGS for 1927. In this paper she dealt with placentation, the growth of corpora lutea, and the extraordinary growth of extra-embryonic mesoderm in these lizards. She has also studied in detail placentation in *Lygosoma* (*Hinulia*) *quoyi* and placed the results on record in the PROCEEDINGS, with discussion of their bearing on the placentation of the Mammalia. Placentation has also been studied in two viviparous snakes and the results of this will probably be the first record of placentation among snakes.

Miss Weekes proposes, during the coming year, to continue the investigation of reptilian placentation with the ultimate aim of making a study of the evolution of the reptilian placenta and of the extent of its bearing upon the placentation of the Mammalia.

Three applications for Linnean Macleay Fellowships, 1928-29, were received in response to the Council's invitation of 28th September, 1927. I have pleasure in reminding you that the Council re-appointed Miss Ida Alison Brown and Miss Hazel Claire Weekes to Fellowships in Geology and Zoology respectively for one year from 1st March, 1928.

PRESIDENTIAL ADDRESS.

Host and Parasite.

By the late Professor L. Harrison. B.A., B.Sc.

i.—*Introductory.*

I have chosen for the subject of my address the relation between organisms in obligate association under what I call here the host-parasite relation, a matter in which I have been interested for a good many years. The term parasite should, in strict accuracy, be confined to such organisms as live at the expense of their hosts, but I propose to use it loosely to indicate any obligate association, whether parasitic, commensal or symbiotic. Such an association links the parasite to its host in space, as is quite well realized, but curiously little attention has been given to the fact that there is also a linkage in time.

For many groups of parasites host and parasite have come down the ages together. I have dared to fix the origin of bird-lice from psocids as far back as the Jurassic, since there is strong evidence that these existed upon birds and mammals from their very origins, so soon as there were feathers and hair to be eaten. Down that long period of time each generation of hosts has handed on its parasites to its successors. Mammals and birds have changed their forms under the continuous process of evolution, and their lice have changed, too. But parasites in general live under conditions which afford little stimulus to evolutionary change, and so tend to differentiate at a slower rate than their hosts, suffering what I have called elsewhere a retarded evolution.

This relation can be made to serve several useful purposes. The ostriches of Africa and the rheas or nandus of South America are commonly supposed by ornithologists to have arisen from quite distinct stocks. But their lice are so similar, and so different from all other bird-lice, that these must have evolved from a common ancestor, and so also must the birds themselves. Evidence derived from lice is confirmed by the cestode and nematode parasites of the two groups of birds. Thus a phylogenetic relationship may be established by means of parasites. Equally, a supposed relationship may be refuted. Their lice prove that the penguins are in no way related to any northern group of aquatic birds, but belong in an ancient complex which includes the tinamous, fowls and pigeons; that the kiwis of New Zealand are modified rails, and not struthious birds at all; that the tropic-birds are not steganopodes but terns, and so on. A third use is to refute suggestions of convergent resemblance, which are often very lightly made, and which are so exasperating to the zoogeographer since they are usually incapable of either proof or disproof. Leptodactylid frogs are found in South America and Australia. Did they evolve separately, or are they derived from common ancestors? The herpetologist cannot say with any certainty, but the parasitologist discovers that they share a genus, *Zelleriella*, of ciliate protozoan parasites, and must have had common origin. This same example will serve to illustrate a fourth use for the host-parasite relation. The genus *Zelleriella* can, and does, infest frogs other than Leptodactylids. It is not found, however, anywhere except in Australia and South and Central America, so that its distribution affords strong presumptive evidence that South America and Australia have been joined in past time in some way which excluded the northern land masses.

These examples indicate the nature of the host-parasite relation, and its possible usefulness. I propose now to give a short historical account, and to

follow with an examination of some groups of parasites to see how far this usefulness may be of general application.

ii.—*Historical.*

Since the relation between host and parasite is so obvious, it is remarkable that it has received so little attention. I have searched in vain amongst such textbooks of general parasitology as have come under my notice for any reference to it. It seems incredible that there should not be references in serial literature, but, until quite recent times, I have not been able to trace any. This may be due to the fact that such references, if there be any, occur in papers the titles of which give no indication of this aspect of their contents.

Be that as it may, the earliest use of the host-parasite relation to suggest phyletic affinities which I have been able to trace is that by Zschokke, who in a series of papers (1898, 1899, 1907) upon the cestodes of marsupials, has insisted that the common possession of cestodes of the genus *Linstowia* by South American and Australian marsupials clearly indicated their origin from common stock. Two of Zschokke's papers have not been accessible to me, and I have gathered their content from certain criticisms of Zschokke's views by Nybelin (1917). The latter's criticisms do not seem particularly well founded. They are based chiefly upon the well-known fact that many helminths are viable in animals other than their natural hosts. This must be admitted, but it merely demands that care must be exercised in using the host-parasite relation to distinguish between ancient natural associations and those which if not unnatural, are at least of more recent date. No one would suggest, for instance, because the liver-fluke of sheep has been found both in man and the kangaroo in Australia that these animals had any close genetic affinity with sheep.

Kellogg may perhaps be held to antedate Zschokke, since, in his studies of lice, he drew attention to the fact that parasitic species have persisted unchanged from the common ancestor of two or more distinct but closely allied bird-species as early as 1896. But he was long in committing himself to the conclusion that any use could be made of this relationship, as the following quotations from his writings show. After pointing out that he has taken from American birds a number of lice specifically identical with those described from their European congeners, he writes (1896, p. 51):—

"This explanation, I believe, is, for many of the instances, that the parasitic species has persisted unchanged from the common ancestor of the two or more now distinct but closely allied bird-species. With the spreading of the ancestral bird-species, geographical races have arisen within the limits of the species which have, with time and isolation caused by newly appearing geographical barriers (due to geologic or climatic changes), come to be distinct species—species often distinguished only by superficial differences in colour, etc. The parasites have remained practically unaffected by the conditions which have produced the differences among the birds; the temperature of the host's body, the feathers *as food*, all of the environment is essentially unchanged in its relation to the parasite. The parasitic species thus remains unchanged, while the first *Larus* species or *Anas* species becomes differentiated into a dozen or score of specific forms, all with a common parasite."

Between 1896 and 1913 I can find but one sentence in Kellogg's writings which gives any indication that he was pondering upon the further implications involved in the above statement, and that is (Kellogg and Kuwana, 1902, p. 458):—

"It was hoped that the character of the parasites found on the strictly Galapagos Island bird hosts might throw some light on the relationships of these birds to continental genera and species . . ."

This hope was defeated by the extraordinary conditions obtaining on the islands, birds of different orders huddling together promiscuously on the bare rocks, and their parasites becoming hopelessly mixed. In 1913, however, Kellogg came definitely, if timidly into the open (1913, p. 138):—"Of the other Mallophagan genera found on the tinamous two that specially characterize the pheasants and other gallinaceous birds are, by odds, the most commonly represented. And this condition suggests another interesting problem. Is it going to be possible to get suggestions regarding the phyletic affinities of hosts from the character of their parasitic fauna? Take, for example, an order of birds troublesome to the ornithological taxonomists. Will the evidence of the presence on members of this order of certain parasitic genera characteristic of another order indicate their affinities to this second order? It does indeed seem, in the case of the Tinamiformes and Galliformes, as if the evidence from the Mallophagan distribution was in conformity with that suggested by certain structural similarities in the two groups."

In 1914 Kellogg was more emphatic, and he writes (p. 259):—"Also, if it be true that genetic relationship is the determining factor in accounting for the host distribution of the parasites, then it is also true that the distribution of the parasites will indicate in some measure the genetic relationships of the hosts, and that occasional aid in determining the genetic affinities of birds and mammals of doubtful relationships may be had from a study of their parasitic fauna. In my paper already referred to I have pointed out some suggestive cases of this sort in connection with the birds and their parasites."

He concludes (p. 279):—"In the light of the plain statement in Part i of this paper of my belief gained from a study of the distribution of the bird-infesting Mallophaga, to the effect that the host distribution of the permanent wingless ectoparasites of birds is determined more by the genetic relationships of these hosts than by geographic relationships or any ecological condition, and the corollary of this, which is that the distribution of the parasites may therefore often have a valuable significance as to the genetic relationships of animals whose genealogic affinities are in process of ascertainment, and in the light of the facts of distribution for the mammal-infesting Mallophaga and Anoplura as just set out in Part ii of this paper. I hardly need do more, in conclusion, than to point out that the distribution conditions exhibited by the mammal parasites, even in the face of the meagre knowledge that we yet have of the mammal-infesting forms, clearly, on the whole, confirm this thesis. In fact, considering how few mammal-infesting parasite species we yet know, it is surprising how repeatedly the commonness of parasite species to two or more related, although geographically well separated, host species, is illustrated. All through the order from Marsupials to Quadrumana this condition is again and again exemplified. I am then, naturally, made more certain of the essential truth of the thesis, and can the more strongly recommend the attention of systematic zoologists to that practical application of it, which I have stated in the form of a corollary."

My personal connection with this subject dates from 1911, when, after about a year's study of Mallophaga, I read a paper before the Sydney University Science Society upon the possible value of these parasites in determining bird affinities. The manuscript of this paper has been lost, but an abstract was published in the

annual report of the Society for 1911-12, which I quote to show that I had already arrived at some definite conclusions in advance of, and independently of, Kellogg:—

"Wednesday, 16th August (1911).—Held in the Geology Theatre, the President in the chair. L. Harrison read a paper, illustrated with lantern-slides, on "The Taxonomic Value of Certain Parasites." The parasites referred to are the biting lice (Mallophaga) found upon birds or mammals. Owing to both environment and food remaining unchanged through the centuries, these insects have not differentiated as fast as their hosts, and afford indications of original relationship between birds that have diverged widely from parent stock. Though birds can be divided into good natural groups, the relationships between these groups have not, and cannot, be satisfactorily determined on anatomy alone. So any line of investigation that is likely to aid the solution of bird phylogeny deserves consideration. Some evidence is afforded confirming parts of existing classifications. Among other results, a study of the Mallophaga would suggest the inclusion of the penguins with the fowls, pigeons, and tinamous, a relationship that has never before been suggested. Such results could, of course, only be put forward as suggestions to the morphologist. A preliminary examination, however, of this group of parasites, certainly suggests that more complete knowledge will afford valuable clues towards the solution of bird taxonomy."

In 1914 I published a general statement of the host-parasite relation in Mallophaga repeating the suggestion as to the position of the Sphenisciformes, and including *Opisthocomus* in the same grouping (1914, p. 10). I also discussed the genetic connection of the struthious birds. In 1915 I discussed the parasites of the New Zealand kiwis (*Apteryx* spp.), and produced evidence to show that these were more nearly related to the Ralli than to the other struthious birds. Incidentally I produced evidence that the jacanas were ralline rather than limicoline. In the same year I was invited to open a discussion before Section D of the British Association for the Advancement of Science on the general question of host-parasite relations, an abstract of my address being printed in the *Proceedings* for the year. In the following year (1916) I was asked to address the British Ornithologists' Club, and this address appeared in full in *The Ibis*, and in abstract, with an abstract of the discussion, in the *Bulletin* of the Club. In this address I propounded a classification of the petrels based entirely upon their Mallophagan parasites. More recently I have made use of lice and of other groups of parasites both for phyletic and for zoogeographical purposes, statements of which appear in due course below.

The Chairman of the meeting at which I read my first paper in 1911 was Mr. (later Professor) S. J. Johnston. He told me upon that occasion that he proposed to test my ideas with regard to trematodes and cestodes. He subsequently wrote three short papers, which are discussed below.

G. F. Ferris, pupil of, collaborator with and successor to Kellogg at Stanford, naturally imbibed his teacher's ideas, and has made some contributions to the subject which will be discussed when I deal with lice later on.

Metcalf (1921) was, so far as I am aware, the next independent discoverer of the value of the host-parasite method, being led to it by his investigations of the Opalinid parasites of frogs. In a series of subsequent papers he has based the broadest possible conclusions, both phyletic and zoogeographical, upon the distribution of these parasites. We will touch upon his work when dealing with the Protozoa.

Finally Darling's discussion (1921) of hookworm in relation to man is a further example of independent use of the method, and Grobbelaar (1922) has extended S. J. Johnston's discussion of frog trematodes. Theses reverberations are at last beginning to reach the ear of the general parasitologist, and Dr. Henry B. Ward, in his presidential address to the first annual meeting of the American Society of Parasitologists, writes (1926, p. 236):—"The significance of studies in parasitology is by no means limited to the fields I have been discussing. Such studies have been shown to have a direct bearing in individual cases on problems of pure science, such as phylogenetic relationships, distribution and the origin of the parasites and their hosts."

He mentions the work of Kellogg, Metcalf and Darling. This brief historical discussion indicates that the same conclusions have been reached, for the most part quite independently of one another, by a number of workers upon various groups of parasites. This unanimity can mean but one thing, namely that the host-parasite relation is a general principle, and is capable of wide application when parasites are better known. I shall now proceed to consider this relation in some selected groups of parasites.

iii.—*The Host-parasite Relation in Protozoa.*

Wenyon (1926, p. 136) writes on the general host-parasite relation in Protozoa as follows:—

"An important feature of parasitism is the specificity of any particular parasite for its host. It is found in nature that some parasites are unable to live in any other host than the one in which they naturally occur. This undoubtedly depends upon the peculiarity of the body fluids of these animals. Some parasites have become so specialized that they cannot survive in any other fluid than the one to which they have become accustomed. Very frequently, however, a particular parasite is able to live in hosts which are nearly related, the fluids of which may be presumed to differ only slightly from one another. Thus *Plasmodium vivax*, which causes benign tertian malaria, cannot survive in any other vertebrate host than man, though Mesnil and Roubaud (1920) have shown that it may multiply for a short period in the chimpanzee. Other parasites are much less specific, for many of the pathogenic trypanosomes can develop in small rodents, which under natural conditions are never infected by them. In such cases it seems probable that quite apart from the suitability of the fluid of a host, the rapidity with which a host can develop antibodies, is the determining factor as to whether a parasite can establish itself or not. Instances are known in which it is only after many attempts to introduce a parasite into a host that success is at last attained. An instance of this is quoted below (p. 576), where Watson, attempting to isolate a strain of *Trypanosoma equiperdum* from horses in laboratory animals, only succeeded in one after inoculating over 600 animals. The infection, once established, was then readily inoculated from one animal to another. It is evident that here the fluids of the animal which gave a successful result differed from those in which inoculation had failed, or that amongst the organisms injected on the successful occasion there happened to be a few which found the environment congenial and were able to resist the antibodies developed. The fact that subsequent subinoculations were easily carried out seems to suggest that the explanation is to be found in the parasites themselves. Not infrequently an animal which has acquired an infection will free itself, after which it is found to be immune to further inoculations. On the other hand, it has been shown

that in some cases, when an infection has disappeared or has been much reduced, further inoculations of the same organism may bring about a superimposed infection which may be more severe than that first produced. Such an instance has been described by Nöller (1917) in the case of frogs infected with *Trypanosoma rotatorium*.

"It may be stated as a general rule that the specificity of parasitic Protozoa for their particular hosts is much more marked than is the case with vegetable parasites, such as bacteria, yeasts and allied organisms. It often happens that a parasite in one host may be morphologically indistinguishable from one in another, yet experimentally it is impossible to produce cross-infections. Whether such biological races are to be regarded as distinct species or not is a problem which still requires solution. From the strictly zoological point of view they should be regarded as belonging to one."

Despite the generally recognized specificity of protozoan parasites, only one group has been studied from the point of view of host affinities and migrations. The very interesting symbiosis between termites and their flagellate parasites, in which Cleveland (1923) has shown that the flagellates are essential to the continued existence of their hosts, since the parasites alone are able to digest the cellulose of the wood upon which termites feed and to produce substances assimilable by their hosts, indicates a very ancient history of parasitism. Termites and flagellates must have evolved *pari passu* to have reached the present complex condition of interaction. It occurred to me when I first read of this relation that the phenomenon may have a wide general application amongst plant-feeding animals. The striking ciliate and flagellate faunas of the paunch of ruminants, for example, may well prove to have a similar function in aiding the digestion of the cellulose and silica of their hosts' food. Studies have not yet, however, been undertaken along these lines, but I have little doubt that, when they are, there will be a useful crop of by-products in the form of indications of host relationships, etc. I do not intend to traverse the groups of parasitic Protozoa, but will content myself with quoting Metcalf's work (1923, 1923*a*) on the Opalinid ciliates parasitic (commensal) in frogs, since his comprehensive study indicates that similar results may be expected from the careful examination of other parasitic groups.

Metcalf divides the family Opalinidae into two subfamilies, Protoopalininae possessing two nuclei, and Opalininae, comprising multinucleated forms, of which the former is more primitive. This contains two genera, *Protoopalina* (which is divisible into nine subgeneric divisions) and *Zelleriella*. The more specialized subfamily also includes two genera, *Cepedea* and *Opalina*, the latter of which is further divided into two sections, *Opalinae latae* and *O. angustae*. He is of opinion "that *Zelleriella* arose in tropical America from *Protoopalina*; that *Cepedea* evolved from *Protoopalina* probably in southern Asia; that *Opalina* (broad form) was derived from *Cepedea*, apparently in Euro-Asia; that the *Opalinae angustae* arose in south-western North America or in Central America when Hylids, coming north from South America, first met Bufos and Ranas bearing broad *Opalinae*, adopted these parasites and changed them to the narrow form" (1923*a*, p. 393). To quote the full evidence and argument for the above conclusions would take too much space, but we may accept them provisionally as those of the worker most competent to judge. Upon this basis Metcalf discusses the whole broad question of the origin and distribution of the Anura.

What value has such a discussion? Noble (1925) and Dunn (1925), both competent herpetologists, have pooh-poohed it rather contemptuously, and I (1926) have made some reply to their criticisms as far as the Australasian region is concerned. Metcalf has suffered from the usual pitfalls which everywhere beset the path of the generalizer, once he leaves the safe preserve of the group he knows thoroughly. Thus the so-called Bufonids of Australia are not Bufonids at all, but toothless Leptodactylids; there is no Gastrophrynid, nor any frog at all, in Samoa; the record for the Australian *Limnodynastes peroni* in the New Hebrides is erroneous, and is apparently due to a collection of Australian origin having reached the British Museum incorrectly labelled, since other Australian animals have also been wrongly recorded from Erromanga; and finally the position of the New Zealand *Liopelma* is still in doubt. It is pretty certainly a Leptodactylid, but Noble has recently (1922) reaffirmed its status as a Discoglossid. If the data collected from other regions contain similar errors (and I am aware of some) it is small wonder that the generalizer meets with difficulties, and may announce conclusions which are open to criticism.

It would be out of place for me to attempt to follow or to summarize the whole of Metcalf's conclusions as to the past and present distribution of frogs, which he bases upon a study of their Opalinid parasites. I shall, however, briefly consider such of his views as have a bearing upon Australian zoogeography. Australian frogs, if we leave out of consideration four recent immigrants into North Queensland, belong to the families Leptodactylidae and Hylidae.

The Leptodactylidae are parasitized by the Opalinid genus *Zelleriella*, both in Australia and in South America. A few species of *Zelleriella* have apparently pushed up into North America, where they have infested frogs other than Leptodactylids, but the genus is confined to Australia and America. After citing the common possession of this genus of parasite by both Australian and South American Leptodactylids as conclusive evidence against the possibility of convergent development of the two host groups, Metcalf writes (1923, p. 330):—

"It would perhaps be conceivable, though difficult to believe, that the Australian Leptodactylids may have evolved independently of the South American forms now classed in this family. But it is hardly conceivable that almost identical internal parasites were evolved also independently in the two groups of hosts. *Zelleriella* is a very compact genus morphologically, so compact that subdivision into valid species is difficult. The Australian *Z. binucleata* and some American Zelleriellas are especially similar. There seems no escape from the conclusion that the Leptodactylids of America and Australia, and their parasites as well, arose in some one region and spread to their present localities. The evidence for an Antarctic land connection between South America and Australia is greatly strengthened by the data *Zelleriella* and the Leptodactylidae present. Indeed the evidence seems conclusive. . . . It seems in agreement with the data at present known to suppose that a great continental mass existed in the Southern Hemisphere up into Miocene times, and that upon this continent, including Australasia and southern South America, there were Leptodactylids which had *Zelleriella* parasitic in them. *Bufo* was not in this Antarctic fauna."

The Hylidæ are most numerous in South America, dwindle in North America, and are represented in Palaearctica by races of a single species with North American affinities. Elsewhere they occur only in Australia, extending northwards to the Moluccas and the more eastern of the Lesser Sundas. They are absent from South Eastern Asia, which offers an environment essentially suited to

them. Concerning their parasites Metcalf writes (1923*a*, p. 392):—"The Opalinid parasites of the Euro-Asian Hylids, so far as known, are of a modern subgenus (*Opalinae angustae*, evolved, apparently, in the Pliocene), are of North American origin, and are utterly different from any Opalinids known in Australasia. *Opalina obtrigona* was the Opalinid found in all the infected Hylas from Euro-Asia. This is perhaps the most modern of all the Opalinidae. The Australian Hylids, on the other hand, have been found to carry Opalinids only of the most archaic genus, *Protoopalina*, a genus of world-wide distribution. The Euro-Asian Hylid parasite, *Opalina obtrigona*, is almost identical with the North American species *O. obtrigonoidea*, which occurs in several North American genera, including Hylids of five species."

Metcalf's conclusions from parasitological evidence thus support the view generally held by Australian zoogeographers that the Hylids and Leptodactylids entered Australia from the south, and tend to refute that put forward by Matthew (1915), Noble (1922, 1925) and others that these families reached Australia from the north. They also serve to refute Noble's claim that the Australian Leptodactylids are genetically continuous with Asiatic Bufonids. Since only a small part of Metcalf's total conclusions has been discussed, it seems reasonable to hope that a detailed study of other groups of parasitic Protozoa with regard to the affinities and distribution of their hosts will yield results of equal importance.

It should be mentioned, however, that Opalinids are commensals, not true parasites, and appear to be viable in any frogs to which they have access. They are, therefore, less useful than Protozoa which have a strict host-parasite specificity. But inferences such as that drawn from the distribution of the genus *Zelleriella* seem well justified. The genus is absent from the Palaearctic, Oriental and Ethiopian regions, and it may fairly be argued that the ancestors of the existing Leptodactylids have never existed in these regions. The study of host-parasite specificity is in its infancy, but Andrews (1927) after careful cross-infection experiments with coccidiosis in mammals, concludes:—"The coccidia of mammals seem to be strictly host-specific parasites, as judged by cross-infectivity experiments on cats, dogs, rabbits, skunks, opossums, pigs, and prairie-dogs."

iv.—*The Host-parasite Relation in the Temnocephaloidea.*

The Temnocephaloidea are commonly considered as an order of monogenetic Trematodes, but their true affinities appear to lie with the Rhabdocoele Turbellaria. They are somewhat leech-like creatures, with a large muscular posterior sucker, and a series of adhesive tentacles, varying in number, usually arranged in a single row at the anterior end. They have a preponderant obligate association with fresh-water Decapods, but in South America species occur upon fresh-water tortoises and a fresh-water mollusc. A couple of species have been described from fish in the Oriental region, but my colleague Miss Lucy M. Wood, who has for some time been working on the group, will not allow that these are Temnocephaloids. Their normal habitat appears to be upon the external surface or in the gill-chambers of fresh-water crayfishes (Mexico, South America, New Zealand, Australia with New Guinea, Madagascar); but they also occur on fresh-water crabs (South America, New Guinea, Philippines) and shrimps (South America, Australia) and upon the curious archaic Isopod, *Phreatoicopsis*, in Australia. The group is thus confined to the southern hemisphere, save for the anomalous occurrence of a species in Mexico, and a second in the Philippines.

Temnocephala mexicana occurs upon the Potamobiid crayfish *Cambarus digneti* in Mexico, and affords the only known instance of a Temnocephaloid upon the northern crayfishes. This species appears obviously to be a recent derivative from South America. *T. semperi* occurs on *Telphusa* sp. of Sunda, Philippines, and is an extension, like its host, from the Australasian region upon a well-known migration route (Merrill, 1926; Harrison, 1928*a*). The Temnocephaloidea are confined to fresh waters, and show no evidence of marine origin. Their distribution in South America, New Zealand, Australia and Madagascar is coincident with that of the Parastacid crayfishes. I have cited this example (1926, p. 379-382) as affording positive evidence of the connection in past time of these four widely-separated southern land-masses. My argument is further strengthened by a consideration of the distribution of the fresh-water Histriobdellids discussed below (p. xxv). We have here a host-group, itself confined to four southern land-masses, associated with two parasitic groups which are totally unrelated. The first parasitic group is associated with crayfish hosts in all four countries; the second with crayfish in two, and with another fresh-water Decapod in a third, and may yet be found upon crayfish both in New Zealand and South America. When we add to this the circumstance that two species of Phreodrilid oligochaetes are found ectoparasitic in the eye-sockets of Australian crayfish, and that the Phreodrilidae are confined to the extreme south of Africa, Australia and South America, and to the widely separated islands of the sub-antarctic zone, we have a chain of data which, to me, appears to oppose an insuperable obstacle to any hypothesis for the northern dispersal of the southern crayfishes. As I mention below, they appear to me to have been derived at one time and in one place from marine ancestors, and to have achieved their present dispersal by migrations over land routes. This implies either land bridges, or the shattering of an original southern continental mass, as suggested by Wegener. Of the two, Wegener's hypothesis seems the more probable.

The Temnocephaloidea are richest in genera and species in Australia, South America coming next, but with the genus *Temnocephala* only, of which genus New Zealand has two species and Madagascar one. This last will be made the type of a new genus. The group has certainly undergone radiation in Australia, but, when Miss Wood's studies are completed, they will afford some indication that the Australian Temnocephaloids were derived with those of New Zealand, and must have entered from the south. This would imply a derivation from Antarctica, which may have been a centre of radiation for Temnocephaloids. Much depends upon the final determination of the status of the Madagascar species, specimens of which have recently been received for investigation. I must not here anticipate Miss Wood's results, but she is fairly confident that she will be able to do a good deal towards tracing the migrations of the crayfishes themselves when she has completed her survey of their Temnocephaloid parasites. From the viewpoints of both zoogeography and parasitology, the Temnocephaloidea are an important and interesting group.

v.—*The Host-parasite Relation in Trematoda.*

Stiles and Hassall's Index Catalogue of Trematodes (1908) is now twenty years old, and is thus to a certain extent unreliable as a guide to anyone not versed in the systematics of Trematoda. On this account I do not propose to attempt any close investigation of the host-parasite relation in this group, but will rely upon the statements made by S. J. Johnston (1912, 1913, 1914), supplemented

by Grobbelaar's excellent paper (1922) extending Johnston's discussion of the relation between the distribution of frog trematodes and their hosts.

Johnston's analysis (1913, p. 272-3) of the frog trematodes of Europe, America, Australia and Asia shows that in the subfamily Haplometrinae species of *Pneumonoeces* occur in the lungs of frogs of all four continents; and species of *Halipegus* in the buccal cavity of frogs in Europe, America and Asia. In the subfamily Plagiorchinae closely related species occur in the intestine of frogs of Europe, America and Australia, but have not so far been recorded from Asia. Other intestinal parasites belonging to the subfamilies Brachycoelinae and Pleurogenetinae occur in the frogs of all four continents. Bladder parasites belonging to the subfamilies Gorgoderinae and Polystominae are not recorded from Asia, but occur in the remaining three continents, as do rectal parasites of the genus *Diplodiscus* (Paramphistomidae). Grobbelaar (1922) has brought Johnston's work up to date, and has shown that the same relations hold for African frogs. Johnston (*loc. cit.*, p. 276) accounts for this remarkable condition as follows:—

"When the amphibian ancestors of the frogs appeared in the world—long before the frogs themselves—they became . . . infected with a number of forms of trematodes. These trematodes probably much more closely resembled the present day trematode parasites of frogs than did those amphibian ancestors the frogs of to-day, for the worms by that time were an old group of animals, and less likely than the newly evolved amphibian to be very plastic. And, not only so, but their mode of life rendered them less likely to be rapidly affected by environmental changes than free-living animals. As the descendants of those early amphibians dispersed to the four corners of the earth, they took their parasites with them, and while the old amphibians have become altered very considerably, the parasites have probably altered only a little, but still have altered; so that we find the old types of Pneumonoeces, that affected to live in the lungs, represented by a dozen or so species scattered over various parts of the earth. And so on with the others, *e.g.* Gorgoderinae, Brachycoelinae, etc.".

Johnston proceeds to a statement that the trematodes of Australian frogs find their nearest relatives in those of Asiatic frogs, and Grobbelaar accepts this statement. This is against the weight of the zoogeographical evidence drawn from the frogs themselves, and is also against the conclusions drawn by Metcalf from his studies of the Opalinid parasites of frogs, but would accord with the views of Matthew, Noble and others concerning the radiation of frogs from a northern centre of dispersal. It must be borne in mind, however, that Johnston knew only six species of frog trematodes from Asia, that only a small portion of this fauna has been described for Australia, and that nothing whatever was known of the frog trematodes of South America. So we have here an interesting test case for future judgment. When the frog trematodes of Asia, Australia and South America are better known, it will be possible to determine whether those of Australia are more nearly related to the Asiatic or to the South American fauna, a matter which will largely assist in determining the affinities of the frogs themselves. I myself have the utmost confidence, derived from many collateral lines of evidence, that ultimately the closest affinities of Australian frog trematodes will be found to lie with those of South American frogs.

In the same paper (p. 278) Johnston makes brief mention of a few other trematode relationships; the various species of *Scaphanocephalus* from sea eagles in different regions are very closely related to one another, as also are those of

Bilharziella from seagulls and of *Hemistomum* from herons; two species of *Harmostomum* from the Australian marsupials *Dasyurus* and *Perameles* are so closely related to *H. opisthotrias* Lutz from an American *Didelphys* that they must be considered as derived from common ancestors; and finally the flukes from an Australian marsupial and monotreme comprise a subfamily intermediate between the Fasciolinae of higher mammals and the Psilostominae of reptiles and birds.

In 1914 Johnston extended his studies to Australian Trematodes and Cestodes in general; and in 1916 devoted considerable space to a discussion of the relations of the trematodes of Australian birds with those of birds elsewhere. He concludes (1916, p. 254):—

"Of the fifty-one trematodes of Australian birds mentioned in the foregoing table, thirty find their nearest relatives in trematodes parasitic in birds of the same family, ten in birds of a closely related family, and seven in birds which cannot be considered closely related to the Australian bird-hosts, while three are so constituted that they do not seem to have any near relatives amongst known trematodes.

"In the case of the first group and perhaps also of the second, it may be considered that the pairs of related trematodes have been derived from common ancestors, and also that their hosts have been derived from common ancestors, and that the ancestors of the trematodes were parasitic in those of the birds. For instance, *Holostomum hillii* and *H. eraticum*, two closely related species of *Holostomum*, are parasitic in various species of *Larus*. These sea-gulls are apparently derived from common ancestors in which the species of trematode that gave rise to *H. hillii* and *H. eraticum* was parasitic. As the original *Larus* spread over the earth till, in the course of time, it attained the present very wide distribution of the genus, by the acquisition of different characters it became split up into a number of species. Evolutionary agencies were at the same time working on the trematodes which accompanied the birds, and one group eventually became separable from another as a distinct species.

"The want of relationship between the hosts in the case of the seven pairs in the third group, may be explained on the supposition that in the one case or the other the parasite has been acquired by the bird much more recently."

The evidence brought forward by Johnston proves conclusively, I think, that there is a very marked specificity in the relations of trematode parasites to their hosts. Anomalous distributions occur, as in almost any other group of parasites, and these may be due to comparatively recent acquirements which are not natural to the hosts from which they have been recorded. But it is also possible that an extended knowledge of the trematode parasites of vertebrates, of which only a small portion is known, will clear up many of these apparent anomalies, by indicating more precisely the real affinities of the parasites. Trematodes seem likely to be of very real value in affording light upon the relationships and migrations of their host groups.

vi.—*The Host-parasite Relation in Cestoda.*

Although it was in this group that Zschokke indicated for the first time, so far as I am aware, the value of parasites in the determination of host affinities, it nevertheless does not appear to offer, in the light of present knowledge, much useful data for this purpose. Zschokke based his statement upon the common possession by marsupials in America and Australia of cestodes of the genus *Linstowia*. *Linstowia echidnae*, however, is recorded from both a monotreme

and a marsupial in Australia, and these have no close affinity. Moreover, the subfamily Linstowinae includes five genera: *Inermicapsifer*, confined to the mammalian genus *Procavia*; *Linstowia*, which is confined to marsupials and a monotreme, save for a species described from Beddard from the lemuroid *Nycticebus*; *Multicapsiferina*, found in five genera of mammals ranging from rodents to monkeys; *Oochoristica*, which is more characteristic of reptiles, but which is found in marsupials in America and Australia, but is also found in badgers, new world monkeys, armadillos and anteaters; and *Palaia*, found only in reptiles. One might be tempted to suppose that the subfamily is a very ancient one, confined to reptiles and primitive mammals, but an example such as is afforded by *Oochoristica megastoma*, which is recorded from eleven species of new world monkeys, belonging to seven genera, vitiates such a suggestion.

The following data concerning the cestodes of Australian marsupials are taken from Meggitt (1924). *Linstowia* and *Oochoristica* have already been discussed. *Moniezia*, characteristic of ungulates, has a species, *M. bipapillosa*, in the wombat, *Phascolomys mitchelli*. *Cittotaenia*, chiefly found in rodents, has a species in the echidna, and a second in a wallaby, *Lagorchestes conspicillatus*. *Progamotaenia*, *Hepatotaenia*, *Bancroftiella* and *Dasyurotaenia* are confined to Australian marsupials, and their precise affinities are not known. *Pavoniella* has a species in *Macropus brunii*, and occurs elsewhere in two rodents and two pangolins of the genus *Manis*. A species of *Hymenolepis*, probably characteristic of rodents but widely distributed in mammals in general, is recorded from *Perameles macrura*. Species of *Bertiella* occur in phytophagous marsupials of the genera *Phalanger*, *Phalangista*, *Phascolarctos* and *Pseudochirus*, as well as in monkeys, lemurs, and four species of rodents.

Such distributions are frankly incomprehensible. It may be that not enough cestodes are known, or that an adequate means of natural classification has not been attained. But even granting this, the Cestoda appear to exhibit a much greater degree of viability than is shown by the Trematoda. Nevertheless there are some facts which appear to indicate that a host-parasite relation does underlie the apparent confusion. Thus Johnston (1914, p. 243) notes that the same tapeworm, *Davainea struthionis*, is found in both the African ostrich and the American rhea, while a closely related form, *D. australis*, is found in the Australian emu. And many genera do show restriction to a limited host group.

vii.—*The Host-parasite Relation in Nematodes.*

As a basis for the examination of this group, I have used Stiles and Hassall's Index-Catalogue (1920), together with Cram's recent study (1927) of three Nematode suborders parasitizing birds. It must be confessed at the outset that Nematodes do not appear to display any great degree of specificity towards their hosts. Many of the larger genera are cosmopolitan in distribution, and are spread over a startling variety of host groups. On the other hand there are many monotypic genera, or genera with a limited number of species from the same host or host group, from which I can read no meaning, since I am not familiar with the systematics of these parasites, but which might mean more to a specialist in them. There are, moreover, a number of factors which militate against a clear understanding of the relations of Nematodes to their hosts, in the present state of knowledge. Only a small fraction of the group is known; life histories are very largely unknown; distribution may often be determined by that of unknown intermediate hosts; for these, when better known, a more specific host-parasite

relation may hold; the lists of species are clogged with old records, the precise status of which is not known, as well as with misidentifications by more recent workers; and finally the general problem of the viability of Nematode species is far from being fully solved.

A casual survey of Nematode genera appears to indicate that they may be divided roughly into five categories as follows:—

(i) *Genera with species which seem to be able to parasitize any animal group whatever.*

The genus *Heterakis*, for example, is found in various fishes, in frogs and salamanders, in most groups of reptiles, in almost every order of birds, and in such diverse mammals as monkeys, tarsiers, the agouti and the guinea-pig. *H. gallinae* occurs in the bird genera *Anas, Tadorna, Anser, Chenopsis; Ceriornis, Chrysolophus, Colinus, Coturnix, Cupidonia, Gallus, Crossoptilon, Lagopus, Meleagris, Numida, Ortyx, Pavo, Perdix, Phasianus, Bonasa, Tetrao*; and finally *Otis* and *Corvus*; that is to say, in four anseriform and sixteen galliform genera, finishing up with two bustards and a crow. The only conclusion to be drawn from such a distribution is that the species must be viable in almost any kind of bird host, although it must be remembered that the host genera are all commonly kept in zoological gardens, occupying in succession the same enclosures, so that although the parasite may be viable in all these hosts, it may not be a natural parasite of many of them. But a glance down the list of bird-infesting species of *Heterakis* does not offer much promise of definite specificity. Sixteen species are recorded by Cram as having a single host, five as having two closely related hosts (congeneric in three) and two as having two unrelated hosts; while four are found in numerous pheasant genera, and one in thirteen anserines and an owl. A similar history attaches to most of the larger genera, such as *Oxyuris, Physaloptera, Spiroptera* and many more.

(ii) *Genera with species which are confined to predatory groups and their prey.*

This category covers a relation which is very general amongst helminth parasites, especially those which require an intermediate host in their life history. In such organisms the intermediate is the prey of the final host, and harbours some kind of larval stage of the parasite found in its adult form in the final host. Thus in *Dispharynx spiralis* the infective larval stage is found in the terrestrial isopod *Porcellio*, and the adult occurs in a variety of ground-feeding birds, chiefly galliform. The infective larvae of *Echinuria uncinata* occur in the "water-flea," *Daphnia*, and the final stages in aquatic anseriform birds. *Echinorhynchus strumosus* has its larval stages in various fishes, and occurs in the adult form in seals and cetaceans, and so on.

(iii) *Genera either themselves confined, or having species confined, to fairly limited host groups.*

Epomidiostomum is confined to anseriform birds, *Codiostomum* to three species of ostriches in Africa, and *Deletrocephalus* to rheas in South America, *Acanthocheilus* to sharks, *Belascaris* to cats and dogs, *Cylichnostomum* to equidae, *Dictyocaulus, Onchocerca* and *Ostertagia* to ungulates, *Kalicephalus* to snakes, *Prosthecosacter* to cetaceans. Further genera might be cited, but these are sufficient to indicate some kind of obligate relationship between hosts and parasites, the precise nature of which cannot at present be stated.

Amongst species, *Heterakis alata* is found in two species of tinamous in Brazil, as also is *H. valvata; H. hamulus* occurs in two species of peacocks, and *H.*

papillosa in two species of bustards. *Ascaridia hermaphrodita* has been found in nineteen species of South American parrots, belonging to four genera; *A. columbae* in thirteen species of pigeons has a cosmopolitan distribution; *A. cristata* and *A. stroma* are confined to cranes; while *A. numidae* occurs in three species of guinea fowls in Africa. *Viguiera euryoptera* is found in four species of shrikes of the genus *Lanius*, *Acuaria quadriloba* in woodpeckers of several genera in Europe and U.S.A., *Chevreuxia revoluta* in two species of *Himantopus*, and similar limited distributions might be quoted almost *ad infinitum*.

(iv) *Genera which either as a whole or in some of their species appear to afford indications of the underlying genetic affinity of their hosts.*

Few nematode genera fill this condition, but two striking examples may be quoted. The genus *Echinonema* contains two species only, one of which occurs in the marsupial *Perameles obesula* in Australia, the other in the marsupial *Didelphys azarae* in South America. The genetic affinity of the American with the Australian marsupials is confirmed by four separate categories of common parasites, nematode, trematode, cestode and mallophagan. The second example is afforded by the two genera which compose the tribe Deletrocephaleae of the sub-family Strongylinae. These are *Codiostomum*, with a single species found in three species of ostriches in Africa, and *Deletrocephalus*, with a single species occurring in *Rhea americana* of South America. Despite the view generally held by ornithologists that ostriches and rheas are not closely connected, a study of their parasites affords convincing evidence that they are.

These two examples, taken in conjunction with some of those quoted in the preceding section, suffice to show that, underlying the apparent confusion and disorder of nematode distribution, there are traces of a specific host-parasite relation such as is exhibited by most obligate parasites.

(v) *Genera and species the distribution of which is so extraordinarily mixed that no satisfactory conclusions can be drawn from them.*

This fifth category partly overlaps the first, but is meant to apply to conditions other than general viability. Thus the genus *Ornithostrongylus* has a species in the domestic pigeon in Australia and U.S.A., a second in a Brazilian *Leptotila*, a third in the African ostrich, while the fourth and fifth occur in the European bustard and grouse respectively. Even if it be granted that there are many more species to be discovered, no sense can be read into such a distribution, and one suspects at once that the genus is not a natural one. This is Miss Cram's opinion, and she writes (1927, p. 12):—"The pattern of the bursal rays is so divergent in the species included by Travassos in this genus as to raise a doubt as to whether all these species are congeneric."

The genus *Aspidodera* contains five species, two of which occur in marsupials of the genus *Didelphys*, and two in armadilloes belonging to several genera. The fifth occurs in both opossum and armadilloes. Such a distribution cannot be read as indicating genetic affinity, and it may be that some common food factor will ultimately explain it.

In the present state of knowledge it does not appear that nematodes can afford much help in unravelling the affinities of their hosts. But a better knowledge may reveal a different state of affairs. The chief hindrance seems to lie in the very general viability of nematodes. Thus the common gape-worm, *Syngamus trachea*, has achieved an almost cosmopolitan distribution in a wide variety of hosts. Yet Cram (1927, p. 37) is able to show that it is a natural parasite of the

North American turkey, from which it has become transferred to all its other hosts. Bound up with this is the question of the reaction of the parasite to conditions obtaining in a new host, which tends to produce variations which may or may not be of specific value. One need but recall the interminable discussions about the status of the larger species of *Ascaris* found in the domestic animals and man.

Sandground (1926) has made a careful study of this aspect in the genus *Strongyloides*. He writes (p. 66):—"In summing up the consideration of speciation in this genus, I may repeat that the incompleteness of certain records at present permits us to recognize representatives of the genus in mammals only. The parasite in no instance has undergone any fundamental morphological differentiation which can be correlated with physiological adaptation toward special environmental conditions in a particular host species. The most outstanding differences that are recognized in our present conception of specific distinction in the parasitic generation is that of size, but the relation that obtains between a parasite and its hosts must not be disregarded in the evaluation of this character. There appears to be no single character by means of which a specimen may be relegated to its specific position; on the other hand it is, I think, possible to make a determination in a considerable number of individuals if a number of characters representing the different stages in the life-history of the form be jointly considered."

After remarking that some nematodes can successfully invade many hosts, while others are restricted in habit, Sandground proceeds to a general discussion of the phenomena of specificity in nematodes, for quoting which I make no apology, since it embodies the opinions of an expert worker in the group, and has therefore a far greater value than my own. He writes (*loc. cit.*, pp. 68-69):—

"Relatively little attention has been given until very recent times to the study of specificity among nematodes but in the application of parasitology to control work, it may become a subject of no little importance.

"Among nematode parasites of plants, there are some . . . which are polyphagous in their habits. When attempts are made to transfer some of these forms to other host plants, known to be attacked by the same parasite in nature, success does not always follow. . . It seems that the restriction of a population of parasites to a particular host species for a great number of generations leads to a special adaptation towards this species and a corresponding loss of adaptability towards other hosts. This loss may only be temporary but if the parasite be restricted for a sufficient number of generations the probabilities are that the loss will be permanent. The mechanism of this host restriction may be of the nature of a physiological ability to utilize food of only a particular chemical constitution. Should no somatic changes occur in the structure of the parasite during this time, an inability to establish it in its original host under experimental conditions would lead to its being considered as a biological variety but should morphological adaptations develop concomitantly with the development of a host specificity, the parasite would come to be recognized as specifically distinct from its parent stock.

"The situation among nematode parasites of animals is, I believe, closely analogous to that which obtains among nematode plant parasites. The development of structural differences in certain groups of nematodes which parasitize different hosts is sometimes of a low order. The degree in which it occurs may

depend upon several factors, such as the intrinsic plasticity of the parasite, the extent to which the change in environment in a new host calls for special adaptations, an evolution time factor, as well as upon other factors of a more obscure or less intelligible nature. Several intermediate gradations may be recognized in the evolution of a complete specificity of a parasite towards its definitive host. When embryonated eggs of several species of Ascaris are fed to abnormal hosts, the larvae which hatch from the eggs undergo the normal migration through the vascular system and lungs but when they return to the intestine, they are unable to establish themselves and are passed out of the body. The parasite shows different degrees of adaptation to different host animals. In some animals (rats, guinea pigs, etc.) *Ascaris lumbricoides* is eliminated at an early stage, while in other animals (sheep, goats) the larvae can develop to a stage approaching maturity before they are out of the intestine. There are many who recognize a specific distinction between parasites which although morphologically indistinguishable appear to possess a high order of host specificity; thus for example *Ascaris lumbricoides* and *A. suum*. Although this procedure may not be warranted from the point of view of the systematist, from the standpoint of applied parasitology it is probably justifiable. The ability of a parasite to proceed to a certain stage in its development in an abnormal host may be further illustrated by the example of the human hookworm, *Ancylostoma duodenale*, which according to Looss and other observers is able to develop in young dogs almost to the mature stage before passing out of the abnormal host. In *Strongyloides* a most advanced condition is encountered; certain species, as will be shown later, develop to maturity in certain abnormal hosts and proceed to produce young but after a shorter or longer time the prolificity of reproduction gradually diminishes and eventually ceases, presumably with the death of the parasites."

Sandground follows with an account of some infection experiments, the most interesting of which is that with *Strongyloides fülleborni*, a common parasite of old world monkeys, including anthropoids. He did not succeed in inducing infections in dogs, cats or rats, but produced a small infection, persisting up to the eighth day, in man. Using *Ateles geoffroyi*, a new world monkey, he was able to secure a few larvae after five and six days, but failed in several attempts to reinfect. He concludes that the old and new world *Strongyloides* are distinct, but these experiments also suggest, though the evidence is slender, the closer affinity of man to the old world monkeys, and the more remote affinity of the genus *Ateles*, which, it is of interest to note, harbours a louse of the genus *Pediculus*, otherwise confined to man and the old world anthropoids.

Finally Darling (1920, 1921), who was a leading authority on hookworm, has actually used the host-parasite relation of the hookworms of man, *Ancylostoma duodenale* and *Necator americanus*, as a basis for some interesting and suggestive speculations as to the interrelations and wanderings of the races of man. After stating (1921, p. 323) that either species is equally viable in any kind of man, he points out that holarctic peoples show a marked predominance of *A. duodenale*, while the predominant parasite in peoples of the Oriental and Ethiopian regions is *N. americanus*, which he found also in uncontaminated Fijians. He suggests that a survey of uncontaminated American Indian communities may indicate the origins of these peoples, and further that it may be possible to revise the ancestral tree of the primates after a study of the host relationships of their respective obligate nematode parasites.

It thus becomes evident, despite the hopeless confusion which the nematodes present to a generalizer not conversant with the group, that, in the hands of experts and after they are better known, they will afford the same kind of evidence of host relationships as do other obligate parasites.

viii.—*The Host-parasite Relation in Histriobdellids.*

The Histriobdellidae are a family of primitive worms which are generally included in the Archiannelida, although they show no very obvious relationships with any other members of this group, and in some respects come nearer to the Trochelminthes. The family is a small one, comprising, so far as is at present known, only five species contained in two genera. These are:—

Histriobdella homari van Beneden, found upon a European marine lobster, *Nephrops norvegicus*.

Stratiodrilus tasmanicus Haswell, found upon the Tasmanian crayfishes, *Astacopsis tasmanicus*, *A. franklini*.

Stratiodrilus novae-hollandiae Haswell, found upon the Australian crayfish, *Astacopsis serratus*.

Stratiodrilus haswelli Harrison, found upon the Madagascar crayfish, *Astacoides madagascariensis*.

Stratiodrilus platensis Cordero, found upon a fresh-water anomurous crab, *Aeglea laevis*, in Uruguay.

Both genera have an obligate association with the gill filaments of decapods, upon the surface of which they normally live, though whether as parasites or as commensals has not been accurately determined. *Histriobdella*, the more primitive genus, is marine and has been found only in the northern hemisphere. *Stratiodrilus* is found in fresh waters of the southern hemisphere, in land masses as widely separated as South America, Australia and Madagascar, and its characteristic association appears to be with the southern crayfishes of the family Parastacidae, which are distributed in South America, New Zealand, Australia and Madagascar. I have dealt with these in more detail above, when discussing the host-parasite relations of the Temnocephaloidea. I have recently (1928) described and figured the species of *Stratiodrilus* from Madagascar, and figured also the South American species, and have drawn the following conclusions:—

"It seems reasonable to conclude that *Stratiodrilus* comes of marine ancestors, and that it, or an ancestral form of it, lived upon the marine forerunner of the Parastacid crayfishes. The transition to fresh-water conditions must have taken place once, and once only, upon a single land mass, for, even if it be argued that there were several migrations of marine Decapods carrying Histriobdellid parasites from the sea to the fresh waters of widely separated southern lands, these could not have received fresh-water Temnocephaloid parasites, which again must have had common origin on a single land mass. The association of the Parastacid crayfish with two unrelated parasitic groups, one probably of marine origin, the other giving no evidence of such an origin, seems to me to demand conclusively that there should have been land connections between Madagascar, Australia, New Zealand and South America in past time. Wegener gives the most plausible suggestion, and I have discussed this elsewhere (Harrison, 1928*a*). A difficulty would arise in connection with the absence of crayfishes from Africa, and it must be supposed that Madagascar had no land connection with Africa after it had received its crayfishes from the east."

ix.—*The Host-parasite Relation in Lice.*

Both biting and sucking lice are now included in a single order, Anoplura, following upon the work of Mjöberg, Kellogg and myself. I have further shown (1916) that the sucking lice are an offshoot of the more specialized suborder of biting lice, the Ischnocera. The work of Snodgrass (1896) has indicated quite clearly that the Anoplura as a whole are derived from the Copeognatha. The Anoplura are now divided into three equivalent suborders, Amblycera and Ischnocera comprising the biting lice, and Siphunculata the sucking lice. The interrelations of these are not quite clear. The Amblycera constitute the more generalized type, but show no obvious intergrades towards the Ischnocera, the two suborders being very sharply cut off from one another. My own opinion is that they represent an earlier and a later independent derivation from psocid stock. The Siphunculata are certainly derived from the Ischnocera, and a link in this derivation is certainly provided by the elephant louse, *Haematomyzus*, which is so distinct from either (Harrison, 1919) that it is probably entitled to equivalent subordinal rank.

The more primitive Amblycera are two-clawed (except for the family Gyropidae, in which one claw has become lost) and have the antennae concealed in a fossa beneath the head. The Ischnocera and Siphunculata have the antennae freely exposed laterally, and have but a single functional claw. All Ischnocera save the Trichodectidae, however, exhibit a non-functional second claw, in various stages of reduction, and not connected with the flexing apparatus of the tarsus, which accounts for the usual statement that the Ischnocera are two-clawed. *Haematomyzus*, *Scipio* and *Hybophthirus* amongst the Siphunculata show similar traces of derivation from a two-clawed condition.

The host relations of these major groups are of considerable interest. The Amblycera occur upon birds, upon marsupials both in Australia and in South America, and upon a certain number of rodents in South America only, and not in any other part of the world. Those which occur upon mammals are at present included in three families, the Boopidae on Australian marsupials, the Trimenoponidae upon marsupials and rodents, and the Gyropidae upon rodents in South America. Ferris (1922, p. 76) has discussed this somewhat anomalous distribution as follows:—

"As has been many times pointed out, one of the most interesting problems in connection with the study of these ectoparasites is that of their distribution. This is, at least in part, the problem of the genetic relationships of their hosts. Just how far the two problems are concurrent is the most fascinating aspect of it all. In the case of the South American two-clawed species infesting mammals it is evident that the two problems diverge rather early, at least if we may form any conclusions from the rather scanty amount of information that is available.

"The majority of the two-clawed Mallophaga from mammals have been taken from marsupials in Australia and for these Harrison has named a distinct family the Boopidae. Two of the species herein dealt with are from marsupials, but apparently they find their nearest relatives not in the Australian marsupial-infesting species but in other species from South American rodents. The one consolation for those of us who like to see our theories work as they should is that these two species are apparently referable to the same genus. Of the other three species, one is from members of the rodent family *Lagostomidae*, one from the family *Octodontidae*, and one from the family *Caviidae*. There is at least a

suggestion that here the problem of the distribution of the parasites is in large part geographical.

"A similar situation appears to exist in the case of the Mallophagan family, *Gyropidae*, the members of which occur upon mammals that appear to have little more in common than the circumstance that all are South American."

Ferris's paper, published in England, anticipated by a fortnight one of my own bearing practically the same title published in Australia, in which I wrote (1922, p. 154) as follows:—

"Mallophaga from Australian marsupials are contained in a family, the Boopidae, which finds its closest relations in the Gyropidae, a family found upon certain South American rodents. Certain South American rodents also harbour the two contained species of a third family, the Trimenoponidae. With the exception of these three small groups, all mammalian Mallophaga belong to the widely different family Trichodectidae, which is placed in a distinct super-family.

"Believing as I do that Mallophagan parasites afford valuable indications as to the genetic relationships of their hosts, I have always been puzzled by this distribution. That the marsupials of Australia should not carry the same kinds of parasites as the Eutherian mammals is reasonable enough. But, apart from marsupials, I should have expected all other mammalian Mallophaga to belong to the Trichodectidae. Hence the occurrence of two small, but distinct, families, not upon rodents in general, nor even upon American rodents in general, but on a limited number of South American rodent species, families which showed, moreover, some relationship with the Boopidae, but differed from all other Mallophaga, was difficult to reconcile with my ideas.

"The explanation would appear to be that such Amblyceran Mallophaga as occur on South American rodents have been migrants in the past from the marsupial stock. The new genus which I describe from a South American marsupial must be placed in the Trimenoponidae, but shows marked features of resemblance to the Boopidae, and some points of contact with the Gyropidae. It is, of course, no use trying to base definite conclusions on a single marsupial-infesting species, but it seems likely that, when more information is available concerning the Mallophagan parasites of American rodents and marsupials, the suggestion thrown out here may be upheld. It is also possible that the discovery of further connecting forms will make it advisable to unite these three anomalous groups under one family name."

The additional information contained in Ferris's paper confirms me in my opinion. The marsupial fauna of South America is a dwindling remnant of once dominant forms, as is indicated by the rich deposits of marsupial remains found by Ameghino. *Peramys* and *Caenolestes*, marsupials from which Ferris records two-clawed Mallophaga, are small creatures of rodent-like habit and habitat. Unless it be assumed that these and their like have passed their parasites on to rodents sharing their haunts, we must accept a condition otherwise unprecedented amongst lice, which have no zoogeographical distribution independent of their host groups. That two-clawed Mallophaga are viable on other than their natural hosts is well shown by the large number of records of the taking of *Heterodoxus*, a Boopid genus absolutely characteristic of the Australian marsupial genus *Macropus*, upon dogs, foxes and coyotes in various parts of the world. Paine was so much impressed by this fact that he has stated (1912, p. 361) that this genus is mammal infesting, probably characteristic of dogs.

The Amblycera, then, appear to be natural parasites of birds and marsupials, while the Ischnocera are natural parasites of birds and placental mammals. The Siphunculata are entirely confined to placental mammals. This distribution suggests a very ancient history of parasitism, and, taken with other available data, has led me to the opinion that the Amblycera parasitized birds and marsupials before the placental mammals came into existence, while the Ischnocera and Siphunculata are of later origin than the marsupials themselves. Since, however, the two latter groups have a cosmopolitan distribution upon placentals, they must be practically as ancient as these mammals. Consequently we have a history of parasitism for all three groups which must cover practically the whole period of evolution of their hosts. Since the parasites have not, in general, evolved at so rapid a rate as their hosts, their relationships may be more easily traced, and will in many cases afford suggestive evidence as to host affinities.

I do not intend to discuss the Amblycera in any detail. They are more active than the Ischnocera, tend to wander from the body of the host after death, and seem to be able to live without inconvenience upon other than their natural hosts. In general, however, they display a specific host-parasite relation, and, when better known, will probably prove almost if not quite as useful as the Ischnocera for the purpose of assessing host affinities. Those genera which have been definitely delimited in recent years exhibit precise host relations. The genus *Tetrophthalmus* is confined to pelicans, *Eomenopon* to parrots, *Trochiloecetes* to humming-birds, and so on. Ferris and Uchida are in process of making critical studies of the suborder, and, when these are completed, the results will very certainly lend themselves to a consideration of host relationships.

The Ischnocera, however, are much more valuable from this point of view. They are more diversified in form, exhibit a better range of characters, and show a much higher degree of specificity towards their hosts. This last is very largely due to the fact that they do not leave the body of the host at death, but fix themselves by their mandibles to feathers or hair, and die *in situ*. They may, in consequence, be easily, and for the most part safely, collected from dried skins in museums, and it is of passing interest to note that I have a fairly considerable collection taken from skins collected by the *Challenger*, as well as a few dating back to the voyage of the *Beagle*.

The condition among the Ischnocera is such that the parasites of any host group have a common facies, and are recognizable at sight as coming from a particular host group. I should scarcely be justified in saying that I could name the host group for any Ischnoceran that was submitted to me, since there are some groups of birds with whose Ischnoceran Mallophaga I am not familiar. But for all well-known groups of birds with a wide distribution I could say without hesitation that a given louse came from a crow, a kingfisher, a cuckoo, a parrot, a gannet, a petrel, or such other bird as might be. For those groups which I have studied most intensively I would go even further. For almost all Ischnoceran parasites of the Tubinares, for instance, I could name the actual genus of petrels from which any louse shown me was derived.

There can be no doubt whatever that the Ischnoceran Mallophaga have evolved *pari passu* with their host groups, and that the latter carry their appropriate parasites whether at the pole or the equator. After a number of years of study I am just bringing to conclusion a critical examination of the Ischnocera as a whole, which will involve the diagnosis of upwards of a hundred new genera, and which will exhibit the main lines of evolution within the

group. I do not propose to anticipate here the results of this study, but, although inadequacy of material in certain directions has rendered these less complete than I had hoped, I shall nevertheless be able to discuss the broad lines of bird evolution upon the basis of their Ischnoceran parasites, and to suggest a certain number of emendations in bird classification.

The Siphunculata are even more specific in their host relations than the Ischnocera, but are not yet well enough known to be of much use in questions of host relationships. Ferris (1919, 1921, 1922, 1923) is engaged in monographing the group, and, when his work is completed, it should be very valuable from this point of view. Kellogg (1913*a*) has shown that man and the anthropoids share a genus of sucking lice which is distinct from that found upon the lower monkeys.

x.—*The Host-parasite Relation in Other Insects.*

Amongst insects there are many parasitic groups, especially in the Diptera and Hymenoptera. These have not been studied from the point of view of host relations, but my colleague, Mr. A. J. Nicholson, informs me that there does not appear to be any strict specificity towards insect hosts. Phytophagous insects, on the other hand, exhibit in many cases an absolute specificity towards the plants which they parasitize, but so far little attention has been paid to this relation. Dr. G. A. Waterhouse has kindly given me some brief notes upon the food-plants of Australian butterflies. In the genus *Papilio*, species of the subgenus *Pharmacophagus* feed upon *Aristolochia*, rarely upon allied plants; those of the subgenus *Papilio* chiefly upon Rutaceae (more especially citrus fruit trees), but also upon Umbelliferae; those of the subgenus *Cosmodesmus* upon Anonaceae. *Delias* feeds on *Loranthus*, *Elodina* and *Huphina* on *Capparis*, *Catopsilia* and *Terias* on *Cassia*, the Danaida on Asclepiadeae. Many Lycaenids feed upon Leguminosae, others upon *Loranthus*. Satyrids and some Hesperiids feed on monocotyledons, in many cases being limited to single genera, e.g. *Tisiphone* and *Hesperilla* on *Gahnia* and *Trapezites* on *Xerotes*. It is possible that some significance may attach to the fact that these archaic groups are confined to monocotyledonous plants. In any event the whole question of host-parasite relations in insects seems worthy of further study.

xi.—*Conclusion.*

The foregoing far from exhaustive discussion brings out clearly enough, I think, that there is a general specificity underlying obligate host-parasite relations, however much this may, in some groups, be obscured by the interposition of other factors. Parasites have evolved *pari passu* with their hosts and the history of parasitism goes far back in time. Parasites may therefore quite justifiably be used to aid in the solution of problems affecting their hosts in the various ways indicated in my opening remarks. Where evidence can be derived from more than one group of parasites, as for example in the cases of struthious birds and fresh-water crayfishes which I have mentioned, its value is greatly increased.

In conclusion, I should like to plead not only for a wider application of this host-parasite relation to zoological problems in general, but, also, and more particularly, for the more careful collection of all groups of parasites. Any mammal or any bird harbours parasites without and within which may prove of more value in determining its affinities and status than the skin which is usually the sole trophy of the collector. No parasitic group is at all well known, and until this state of affairs is altered the host-parasite method cannot attain to its full usefulness.

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On the motion of the Chairman, the following resolution was carried in silence, the Members standing: The Members of the Linnean Society record their deep sorrow at the loss of their President, Professor L. Harrison, whose sudden and unexpected death has stricken his colleagues and friends with grief. Australian Science has lost one of its most brilliant zoologists and one of its most inspiring teachers of zoology, and this Society has lost one of its most valuable members whose place will be difficult to fill. The Members express their sympathy with Mrs. Harrison in her sad bereavement.

Dr. G. A. Waterhouse, Hon. Treasurer, presented the balance sheets for the year ending 31st December, 1927, duly certified as correct by the Auditor, Mr. F. H. Rayment, F.C.P.A., Incorporated Accountant; and he moved that they be received and adopted, which was carried unanimously.

No nominations of other Candidates having been received the Chairman declared the following elections for the ensuing Session to be duly made:—

Members of Council: W. R. Browne, D.Sc., R. H. Cambage, C.B.E., F.L.S., W. W. Froggatt, F.L.S., A. J. Nicholson, M.Sc., F.E.S., G. A. Waterhouse, D.Sc., B.E., F.E.S.

Auditor: F H. Rayment, F.C.P.A.

Linnean Society of New South Wales.

GENERAL ACCOUNT. Balance Sheet at 31st December, 1927.

LIABILITIES.	£ s. d.	£ s. d.
Capital: Amount received from Sir Wm. Macleay during his lifetime	14,000 0 0	
Further sum bequeathed by his Will	6,000 0 0	
		20,000 0 0
Contingencies Reserve		9,000 0 0
Income A/c at 31st December, 1927		292 11 8
Fletcher Memorial Fund at 31st December, 1927		23 17 0
		£29,316 8 8

ASSETS.	£ s. d.	£ s. d.
Society's Freehold		11,000 0 0
Investments: Commonwealth Loans	10,674 11 0	
N.S.W. Debentures	470 0 0	
Loans on Mortgage	6,600 0 0	
		17,744 11 0
Cash: Current A/c	37 3 6	
Savings Bank	524 14 2	
In hand	10 0 0	
		571 17 8
		£29,316 8 8

INCOME ACCOUNT. Year Ended 31st December, 1927.

	£ s. d.	£ s. d.
To Salaries and Wages		1,336 15 0
„ Printing Publications	739 6 6	
„ Illustrations	172 17 6	
		912 4 0
„ Rates and Insurance		262 13 6
„ Postage	61 10 2	
„ Audit	7 7 0	
„ Printing and Stationery	30 6 6	
„ Expenses	44 9 6	
„ Petty Cash	34 19 2	
„ Attendance	15 0 0	
„ Bank Expenses	2 16 9	
		196 9 1
„ Library and Bookbinding		153 3 1
„ Appropriation: Contingencies Reserve		1,000 0 0
„ Fletcher Memorial Fund		2 2 0
„ Balance to 1928		292 11 8
		£4,155 18 4

	£ s. d.	£ s. d.
By Balance from 1926		673 5 1
„ Subscriptions: 1927	162 15 0	
Arrears	5 5 0	
In Advance	6 6 0	
		174 6 0
„ Life Subscriptions		47 5 0
„ Entrance Fees		16 16 0
„ Interest		962 7 5
„ Rents		655 2 3
„ Sales (including 100 copies of Proceedings purchased by Government of New South Wales)		205 18 3
„ Fellowships A/c (surplus income transferred)		1,168 16 4
„ Subscriptions to Fletcher Memorial		2 2 0
„ Compensation on evacuating Hall at Elizabeth Bay		250 0 0
		£4,155 18 4

Examined and found correct. Securities produced.
F. H. RAYMENT, F.C.P.A.,
Sydney, 8th February, 1928. Auditor.

G. A. WATERHOUSE,
Hon. Treasurer.
Sydney, 9th January, 1928.

LINNEAN MACLEAY FELLOWSHIPS ACCOUNT.

BALANCE SHEET at 31st December, 1927.

LIABILITIES.	£	s.	d.	ASSETS.	£	s.	d.
Amount bequeathed by Sir Wm. Macleay	35,000	0	0	Commonwealth Loans	8,540	0	0
Surplus Income capitalised	10,650	0	0	N.S.W. Debentures	530	0	0
				Loans on Mortgage	36,580	0	0
	£45,650	0	0		£45,650	0	0

INCOME ACCOUNT. Year Ended 31st December, 1927.

	£	s.	d.		£	s.	d.
To Salaries of Linnean Macleay Fellows	1,069	19	1	By Interest	2,842	18	9
,, Fellows' Subsidies	74	3	4				
,, Capital A/c	530	0	0				
,, General A/c	1,168	16	4				
	£2,842	18	9		£2,842	18	9

Examined and found correct. Securities produced.
F. H. RAYMENT, F.C.P.A.,
Sydney, 8th February, 1928. Auditor.

G. A. WATERHOUSE,
Hon. Treasurer.
Sydney, 9th January, 1928.

BACTERIOLOGY ACCOUNT.

BALANCE SHEET at 31st December, 1927.

LIABILITIES.	£	s.	d.	ASSETS.	£	s.	d.	£	s.	d.
Amount bequeathed by Sir Wm. Macleay	12,000	0	0	Commonwealth Loans				14,800	0	0
Accumulated Income capitalised	2,000	0	0	Cash: Commercial Banking Company	266	4	1			
Income A/c at 31st December, 1927	1,194	16	6	Government Savings Bank ..	128	12	5			
								394	16	6
	£15,194	16	6					£15,194	16	6

INCOME ACCOUNT. Year Ended 31st December, 1927.

	£	s.	d.		£	s.	d.
To Salaries and Wages	503	6	8	By Balance from 1926	1,039	12	4
„ Expenses	88	5	2	„ Interest	752	16	0
„ Petty Cash	6	0	0				
„ Balance to 1928	1,194	16	6				
	£1,792	8	4		£1,792	8	4

Examined and found correct. Securities produced.

F. H. RAYMENT, F.C.P.A.,
Auditor.

Sydney, 8th February, 1928.

G. A. WATERHOUSE,
Hon. Treasurer.

Sydney, 9th January, 1928.

ABSTRACT OF PROCEEDINGS.

SPECIAL GENERAL MEETING.

28th MARCH, 1928.

Mr. R. H. Cambage, C.B.E., F.L.S., Vice-President, in the Chair.

Business: To elect the President and a Member of Council for the year 1928-29.

The Chairman explained that the elections for which the Special General Meeting had been called were rendered necessary by the death of Professor Harrison, who had been nominated as President for 1928-29 and also as a Member of Council, but whose death took place after the closing date for nominations. The elections, therefore, were to be made at a Special General Meeting in accordance with Section 10 of the Society's Act of Incorporation.

Election of President: Assistant-Professor W. R. Browne, D.Sc., was unanimously elected President for the Session 1928-29.

Election of Member of Council: The vacancy on the Council was filled by the election of I. M. Mackerras, M.B., Ch.M., B.Sc.

ORDINARY MONTHLY MEETING.

28th MARCH, 1928.

Dr. W. R. Browne, President, in the Chair.

The Donations and Exchanges received since the previous Monthly Meeting (30th November, 1927) amounting to 46 Vols., 323 Parts or Nos., 37 Bulletins, 10 Reports and 5 Pamphlets, received from 139 Societies and Institutions and 6 private donors were laid upon the table.

PAPERS READ.

1. Notes on Australian Coleoptera, with Descriptions of New Species. Part i. By Charles G. Oke.

2. The Loranthaceae of Australia. Part vii. By W. F. Blakely.

3. The Growth Rings in the Wood of Australian Araucarian Conifers. By W. D. Francis.

ORDINARY MONTHLY MEETING.

27th APRIL, 1928.

Dr. W. R. Browne, President, in the Chair.

Mr. JACOB HAROLD SMITH, Brisbane, and Mr. THOMAS ARNOLD WILLIAMS, Murgon, Queensland, were elected Ordinary Members of the Society.

The Chairman announced that Messrs. A. G. Hamilton, R. H. Cambage, H. J. Carter and A. F. Basset Hull had been elected Vice-Presidents and Dr. G. A. Waterhouse, Hon. Treasurer, for the Session 1928-29.

The President offered the congratulations of the Society to Messrs. C. Barnard and I. V. Newman on attaining their M.Sc. degree at the University of Sydney.

The President referred to the death of Mr. William Welch, who had been a member of the Society since 1916.

The President drew the attention of members to the Fifth International Botanical Congress to be held at Cambridge in 1930.

The Donations and Exchanges received since the previous Monthly Meeting (28th March, 1928) amounting to 15 Vols., 126 Parts or Nos., 20 Bulletins, 4 Reports and 24 Pamphlets, received from 88 Societies and Institutions and 1 private donor were laid upon the table.

PAPERS READ.

1. A Revision of the Australian Bombyliidae (Diptera). Part i. By Frederick H. S. Roberts, M.Sc.

2. Crane-flies (Tipulidae, Diptera) from Barrington Tops, N.S.W. By Charles P. Alexander, F.E.S. (*Communicated by Dr. I. M. Mackerras.*)

3. A Review of the Australian Species of *Corysanthes* (Orchidaceae). By the Rev. H. M. R. Rupp, B.A., and W. H. Nicholls.

4. Fossil Plants from Plutoville, Cape York Peninsula. By A. B. Walkom, D.Sc.

NOTES AND EXHIBITS.

Mr. E. Cheel exhibited a fresh flowering specimen of "Spear Thistle" (*Carduus lanceolata*) with white flowers. The seeds were collected from plants naturalized at Maclean (North Coast district) which have apparently become fixed, as there were several plants in the neighbourhood with white flowers. So far, all the plants grown at Ashfield from the seeds collected at Maclean have produced white flowers.

Dr. F. N. Blanchard (University of Michigan) exhibited specimens of the frog *Crinia tasmaniensis* which he had collected in Tasmania during January. This species was originally described by Günther in 1864 from specimens collected in Tasmania and preserved in the British Museum, but seemed to have been lost as it had apparently not been again collected from Tasmania. Since Dr. Blanchard had collected it, however, specimens had been found in the Australian Museum, collected by Professor E. J. Goddard in 1909, and the late Charles Hedley in 1911.

Professor T. D. A. Cockerell, Professor of Zoology in the University of Colorado, delivered a short address on "Wild Bees".

ORDINARY MONTHLY MEETING.

30th May, 1928.

Dr. W. R. Browne, President, in the Chair.

Miss Daphne Lydia Goulston, Centennial Park, Sydney, was elected an Ordinary Member of the Society.

Letters were received from Messrs. C. Barnard and I. V. Newman, returning thanks for congratulations.

The President announced that the Council has decided to advertise the position of Macleay Bacteriologist in Australia and New Zealand and also in England. A salary of £600 per annum will be offered and applications will close on 30th November, 1928. A circular containing information for intending applicants will be available at an early date.

The President announced that the Council has decided to institute a series of memorials to distinguished members of the Society who have died. The memorials will take the form of an extended biography, bibliography, portrait,

and other suitable matter; they will be issued separately and will also be printed in the Proceedings. Of the members who have died since 1st January, 1925, the date fixed for the commencement of the Memorial Series, the Council has decided to prepare memorials of Professor W. A. Haswell, Mr. C. Hedley and Mr. J. H. Maiden. Any information that members may be able to afford concerning these three former members will be welcomed.

The President referred to the death of Professor J. V. Danes, a former member, at Pasadena, California.

The Donations and Exchanges received since the previous Monthly Meeting (27th April, 1928) amounting to 9 Vols., 135 Parts or Nos., 17 Bulletins, 3 Reports and 28 Pamphlets, received from 73 Societies and Institutions and 3 private donors were laid upon the table.

PAPERS READ.

1. The Physiography of the Cox River Basin. By F. A. Craft, B.Sc.

2. The Larva of *Hemiphlebia mirabilis* (Odonata). By R. J. Tillyard, M.A., Sc.D., D.Sc., F.R.S.

3. The Geology of the South Coast of New South Wales. Part i. The Palaeozoic Geology of the Moruya District. By Ida A. Brown, B.Sc., Linnean Macleay Fellow of the Society in Geology.

NOTES AND EXHIBITS.

Professor Sir Edgeworth David exhibited specimens of the extensive fauna of archi-annelids and archi-arthropods recently found by him in the, probably, Pre-Cambrian rocks of the Adelaide Series of South Australia, and the Nullagine Series of Western Australia, both in the Pilbara Region and over the Kimberley and Wyndham areas. This new fauna is rich in forms, and the minute appendages of the fossils are in many cases exquisitely preserved. These fossils commence at about 2,000 feet below the base of the known fossiliferous Lower Cambrian, and extend to about 10,000 feet stratigraphically lower. For the privilege of examining a number of the rocks in which the fossils have now been found he is indebted to his colleague Professor W. Howchin.

Mr. E. Cheel exhibited live plants of a native "Buttercup" (*Ranunculus* sp.) probably undescribed, collected originally on Lake George by Mr. H. Fester. Plants kept in a semi-submerged condition flowered during December last but failed to set their achenes. When pollinated with pollen taken from *Ranunculus rivularis* the flowers set their seeds. The resultant seedlings (6 of which are thriving) developed three trifid leaves following the cotyledons, similar to those of the parent plant from Lake George, but the lobes of the seedlings are slightly broader. Subsequent leaves are more or less dissected but not nearly so much as those of *Ranunculus rivularis* (the pollen bearer), which are also much more deeply dissected, and have more numerous lobes. The leaves of the seedlings are of a much darker green colour than those of the Lake George plants and also those of *Ranunculus rivularis*. It is intended to continue further observations on the seedlings in order to compare the flowers and achenes with those of the two parent plants.

Mr. W. W. Froggatt exhibited foliage of the "Boree" (*Acacia Oswaldi*), aborted with blister-like galls by a small *Thrips*. Each of these small galls contains an average of about 200 adult *Thrips*. The scar on the underside of the leaf where

the mother thrips entered the tissue has closed up behind her, so that the enclosed insects cannot emerge until the leaf gall contracts and the scar opens. The specimens were collected at Leeton, N.S.W., by one of our members, Mr. Keith McKeown.

Miss Ida Brown exhibited specimens of *Spirifer disjuncta* from the Devonian quartzites of the Moruya District. Two varieties are represented both of which are somewhat different from the form found at Mt. Lambie.

ORDINARY MONTHLY MEETING.

27th JUNE, 1928.

Dr. W. R. Browne, President, in the Chair.

Rev. Ernest Henry Burgmann, Morpeth, N.S.W., and Miss Eileen Leys Durrell, Drummoyne, were elected Ordinary Members of the Society.

The President referred to the death of Mr. John Hopson of Eccleston, N.S.W., who had been a member of the Society since 1918.

The President referred with pleasure to the proclamation issued by the Government extending the existing protection to certain species of wild flowers for a further period of twelve months and including a number of additional species.

The Donations and Exchanges received since the previous Monthly Meeting (30th May, 1928) amounting to 19 Vols., 126 Parts or Nos., 11 Bulletins, 8 Reports and 9 Pamphlets, received from 72 Societies and Institutions were laid upon the table.

PAPERS READ.

1. Fossil Plants from the Upper Palaeozoic Rocks of New South Wales. By A. B. Walkom, D.Sc.

2. On the Life-history of *Ceratodus* (*Epiceratodus forsteri*). By T. L. Bancroft, M.B., Ch.M. (*Communicated by Dr. I. M. Mackerras.*)

3. Notes on Australian Diptera. No. xiv. By J. R. Malloch. (*Communicated by Dr. I. M. Mackerras.*)

4. Lepidodendroid Remains from Yalwal, N.S.W. By A. B. Walkom, D.Sc.

5. The Australasian Species of the Genus *Nemopalpus* Macquart (Diptera, Psychodidae). By C. P. Alexander. (*Communicated by Dr. I. M. Mackerras.*)

6. Revision of the Australian Species of the Genera *Curis*, *Neocuris* and *Trachys*, together with Notes, and Descriptions of New Species of other Coleoptera. By H. J. Carter, B.A., F.E.S.

NOTES AND EXHIBITS.

Mr. A. F. Basset Hull exhibited specimens of a Loricate, *Acanthozostera gemmata* Blv. from Erromanga, New Hebrides, collected by the Rev. J. Campbell Rae. The species has a wide range through tropical Australia and the Pacific Islands.

Mr. A. Musgrave exhibited some specimens of Capsid bugs, *Calocoris norwegicus* Gmelin 1790 = *bipunctatus* Fabricius 1781 (*nom. praeocc.*), from West Devonport, Tasmania. These were sent to the Australian Museum by Mr. H. Stuart Dove, who stated that they had bitten a young man on the back of the hand raising a suppurating swelling which took ten days to heal. The bugs were not represented in the Museum collections and were sent to the British Museum where they were identified by Mr. W. E. China. The species was first recorded from Norway by

Fabricius, but it has since been noted from New Zealand and U. S. America. The occurrence of the species in Tasmania further extends its range, and its ability to inflict injury to man constitutes at least a record for Australia. No members of the family have so far been known to cause suffering to man in Australia.

AMENDMENTS TO THE INTERNATIONAL RULES OF ZOOLOGICAL NOMENCLATURE.*

Upon unanimous recommendation by the International Commission on Zoological Nomenclature, the International Zoological Congress which met at Budapest, Hungary, September 4-9, 1927, adopted a very important amendment to Article 25 (Law of Priority) which makes this Article, as amended, read as follows (the underlined part represents the amendment; the part not underlined represents the old wording):—

ARTICLE 25. The valid name of a genus or species can be only that name under which it was first designated on the condition—

(*a*) That (prior to January 1, 1931) this name was published and accompanied by an indication, or a definition, or a description; and

(*b*) That the author has applied the principles of binary nomenclature.

(*c*) But no generic name or specific name published after December 31, 1930, shall have any status of availability (hence, also, of validity) under the rules, unless and until it is published either—

(1) With a summary of characters (seu diagnosis; seu definition; seu condensed description) which differentiate or distinguish the genus or the species from other genera or species;

(2) Or with a definite bibliographic reference to such summary of characters (seu diagnosis; seu definition; seu condensed description).

And further—

(3) In the case of a generic name, with the definite unambiguous designation of the type species (seu genotype; seu autogenotype; seu orthotype).

The purpose of this amendment is to inhibit two of the most important factors which heretofore have produced confusion in scientific names. The date January 1, 1931, was selected (instead of making the amendment immediately effective) in order to give authors ample opportunity to accommodate themselves to the new rule.

The Commission unanimously adopted the following resolution:—

(*a*) It is requested that an author who publishes a name as new shall definitely state that it is new, that this be stated in only one (i.e. in the first) publication, and that the date of publication be not added to the name in its first publication.

(*b*) It is requested that an author who *quotes* a generic name, or a specific name, or a subspecific name shall add at least once the author and year of publication of the quoted name or a full bibliographic reference.

The foregoing resolution was adopted in order to inhibit the confusion which has frequently resulted from the fact that authors have occasionally published a given name as "new" in two to five or more different articles of different dates—up to five years in exceptional cases.

* This report of proceedings of the Congress is reprinted from *Public Health Reports, U.S. Public Health Service*, 1927, xlii (43), 2639.

ORDINARY MONTHLY MEETING.

25th JULY, 1928.

Dr. W. R. Browne, President, in the Chair.

The President referred to the death of Mr. Bert Bertram, a member who had joined the Society only this year and who was doing very promising work on mosquito control.

The Donations and Exchanges received since the previous Monthly Meeting (27th June, 1928) amounting to 4 Vols., 74 Parts or Nos., 4 Bulletins and 2 Pamphlets, received from 47 Societies and Institutions and 2 private donors were laid upon the table.

PAPERS READ.

1. Notes on Australian Diptera. No. xv. By J. R. Malloch. (*Communicated by Dr. I. M. Mackerras.*)

2. Notes on Australian Diptera. No. xvi. By J. R. Malloch. (*Communicated by Dr. I. M. Mackerras.*)

3. New Species of Australian Erirhinides (Curculionidae). By A. M. Lea, F.E.S.

4. Notes on four little-known Species of Kangaroos. By A. S. Le Souef, C.M.Z.S.

NOTES AND EXHIBITS.

Mr. E. Cheel exhibited specimens of *Casuarina equisetifolia* var. *incana* Poiss., collected at Angourie near Maclean in July, 1927, together with a seedling raised from seed collected at the same time. He also exhibited fresh specimens collected at Nambucca on Thursday, 19th July, 1928, identical with the Angourie specimens. Specimens of typical *C. equisetifolia* collected by the exhibitor in Fiji in July, 1918, have much finer branchlets and smaller fruits which seem to indicate that Allan Cunningham was justified in regarding this as a distinct species. It has previously been recorded from Nambucca by the late J. H. Maiden (Forest Flora, v, 1913, 155, pl. 182) but Angourie is a new locality.

Flowering specimens were also exhibited, on behalf of Dr. G. A. Waterhouse, of *Acacia adenophora* Sieber, which seems to be an undoubted hybrid, as seedlings raised from the *adenophora* forms frequently show characters similar to those of *Acacia Baileyana*, which seems also to have originated as a hybrid. Stages of development of a hybrid, *Acacia dealbata* × *A. Baileyana* were exhibited some years ago (see PROCEEDINGS, 1923, p. xxxiv).

Dr. A. B. Walkom exhibited (1) a specimen of a *Lepidodendron* stem with leaves attached, collected by Mr. C. A. Sussmilch from the Carboniferous north of the Hunter River; (2) some Lepidodendroid remains from the Geology Department, University of Sydney, collected near Eden by Dr. W. G. Woolnough. These specimens resemble some recently described as *Protolepidodendron* from Devonian rocks further to the north at Yalwal; (3) for Dr. Eland Shaw, a series of photographs of Thrips, very greatly enlarged, taken by Mr. Dudley Moulton.

The Secretary has received an inquiry from Mr. William Moore, who is writing a history of Australian Art, as to the existence of portraits or busts of Australians of scientific importance. He has record of the following, and would appreciate any additional information from members of the society:—

Portraits (with artist's name, and locality of portrait): Hon. Alexander Macleay (artist unknown, Australian Museum, Sydney), Prof. A. Liversidge (Hon. John Collier, Sydney University), Rev. W. B. Clarke (Annivitti, Royal Society, Sydney), Rev. John Smith (artist unknown, Royal Society, Sydney), Professor Stephens (Miss Ethel Stephens, Linnean Society, Sydney), Dr. Robert Townson (Augustus Earle, locality unknown), Sir Edgeworth David (Longstaff, Sydney University), Sir Baldwin Spencer (W. B. McInnes, Melbourne University), Robert L. J. Ellery (E. Phillips Fox, Melbourne Gallery), Joseph Henry Maiden (Norman Carter, Botanic Gardens, Sydney), Sir Joseph Banks (Henry Eldridge, Sydney Gallery), Sir Joseph Banks (Lawson Balfour, Commonwealth Collection, Canberra), Allan Cunningham (artist unknown, Commonwealth National Library).

Busts: J. Cosmo Newbury (Percival Ball, Melbourne Gallery), Sir William Macleay (Simonetti, Linnean Society, Sydney).

Statues: Sir Joseph Banks (sculptor unknown, Lands Office, Sydney), Allan Cunningham (sculptor unknown, Lands Office, Sydney).

ORDINARY MONTHLY MEETING.

29th AUGUST, 1928.

Dr. W. R. Browne, President, in the Chair.

Miss Della Lytton Pratt, B.Sc., Lindfield, and Messrs. Thomas Hodge Smith, Australian Museum, Sydney, and Lionel Lawry Waterhouse, B.E., Chatswood, were elected Ordinary Members of the Society.

The Chairman, on behalf of members, offered congratulations to Professor Griffith Taylor on his appointment to a Chair of Geography in the University of Chicago.

Members offered congratulations to Drs. Browne and Wardlaw on their election as Members of the Australian National Research Council, and to Dr. Mackerras, Messrs. Osborne, Kinghorn, Roughley, M. B. Welch, Troughton and L. L. Waterhouse, on their election as Associate Members of the Australian National Research Council.

The President called the attention of members to the conditions announced by the Royal Society of New South Wales to govern the award of the Walter Burfitt Prize.

The Donations and Exchanges received since the previous Monthly Meeting (25th July, 1928) amounting to 44 Vols., 253 Parts or Nos., 9 Bulletins, 1 Report and 5 Pamphlets, received from 74 Societies and Institutions were laid upon the table.

PAPERS READ.

1. The Tanyderidae (Diptera) of Australia. By C. P. Alexander. (*Communicated by Dr. I. M. Mackerras.*)

2. Terrestrial Orchids of Barrington Tops. By Rev. H. M. R. Rupp, B.A.

3. A Revision of the Australian Bombyliidae (Diptera). Part ii. By F. H. S. Roberts, M.Sc.

4. Notes on Australian Lycaenidae. Part vi. By G. A. Waterhouse, D.Sc., B.E., F.E.S.

NOTES AND EXHIBITS.

Mr. David G. Stead exhibited a number of fancy goldfish (*Carassius auratus*, var.), portion of a lot of about 200 bred out from one pair of "plain" goldfish.

The parent fish had the tail lobes just a little elongated, but not long enough to be called "comet-tailed." The progeny showed the greatest variation in colour and form. About 50% were plain carp or goldfish, and the remainder showed every sort of variation in general form of body colour and tail. It was remarkable also that whereas the parents were ordinary "scaled" sorts, many of the progeny were scaleless.

Mr. Stead also drew attention to the early appearance of the common bladder weed or balloon weed; a seaweed that makes its appearance usually considerably later, in September. The unusually warm winter had hastened its appearance. First specimens for the season were seen to-day, and one was exhibited.

Contributions to the discussion on Mr. Craft's paper on the "Physiography of the Cox River Basin" were made by Mr. C. A. Sussmilch, Professor L. A. Cotton and the President. Mr. Craft replied to criticisms of his paper.

ORDINARY MONTHLY MEETING.

26th SEPTEMBER, 1928.

Dr. W. R. Browne, President, in the Chair.

Mr. Edgar Alexander Hamilton, Chatswood, was elected an Ordinary Member of the Society.

A letter was read from Professor Griffith Taylor, returning thanks for congratulations.

The President announced that the Council is prepared to receive applications for Four Linnean Macleay Fellowships tenable for one year from 1st March, 1929, from qualified candidates. Applications should be lodged with the Secretary, who will afford all necessary information to intending candidates, not later than Wednesday, 7th November, 1928.

The President, on behalf of members, offered congratulations to Dr. G. A. Waterhouse and Dr. I. M. Mackerras on their appointment by the Council for Scientific and Industrial Research to the staff of the Division of Economic Entomology at Canberra.

The President announced that, as a representative of the Society, he had attended a meeting called by the Chief Civic Commissioner to arrange a suitable celebration of the bicentenary of the birth of Captain Cook. The main celebration will take place on Saturday, 27th October, the arrangements being in the hands of the Royal Australian Historical Society, aided by a committee appointed at the meeting.

The Donations and Exchanges received since the previous Monthly Meeting (29th August, 1928) amounting to 15 Vols., 95 Parts or Nos., 5 Bulletins and 3 Reports, received from 59 Societies and Institutions and 1 private donor were laid upon the table.

PAPERS READ.

1. Features of the Vegetative Anatomy of the Australian White Beech (*Gmelina Leichhardtii*). By W. D. Francis.

2. A new Buprestid from Australia. By A. Théry. (*Communicated by Mr. H. J. Carter.*)

3. Third Contribution towards a new Classification of Australian Asilidae. By G. H. Hardy.

4. Fossil Plants from the Esk District, Q. By A. B. Walkom, D.Sc.

NOTES AND EXHIBITS.

Mr. A. J. Nicholson exhibited several lantern slides of the "glow-worm" which occurs in some gullies on the Blue Mountains. It is the larva of a mycetophilid fly and possesses a luminous organ at the anal extremity. Each larva constructs a large number of hanging threads on which globules of mucus are arranged like the beads of a necklace. Small insects become entangled in these sticky threads and are eaten by the mycetophilid larvae.

Sir Edgeworth David exhibited some specimens of comparatively well preserved appendages and carapaces of fossil Merostomata, almost certainly Eurypterids, from the Pre-Cambrian or "Lipalian" Adelaide Series. These are from horizons from 6,000 to more than 10,000 feet below the base of the Lower Cambrian fossiliferous rocks. They were found on a recent fossil-collecting expedition by the Rev. P. C. Eckersley and Mr. A. R. Alderman, of the Geology School of Adelaide University, when collecting with Professor David. The Eurypterids were evidently extremely numerous and varied in this Series and to judge from the size of their appendages they must have been from eight inches to more than one foot in length. Considerable interest is added to this Lipalian fauna by the discovery that such highly organized animals as the Eurypterids were so extensively developed and widely distributed at this remote epoch.

Mr. R. T. Baker exhibited a leaf and fruit of *Eucalyptus unialata* forwarded to him by Professor John Read, St. Andrew's University, Scotland, from the subtropical gardens of the Earl of Ilchester at Abbotsbury, Weymouth, in England, where well over 50 Eucalyptus trees flourish. It was labelled in the Gardens as *E. melliodora*, the "yellow box" of the warmer climates of N.S.W., but is undoubtedly this rare species of Tasmania where only a few trees are known to occur. The characteristic single rib of the fruit is well marked, so that its specific identification is assured and is supported by the leaf venation. The other trees growing there are chiefly Tasmanian and this probably accounts for the origin of the seed. It is worthy of note that this rare tree forms the largest group of Eucalyptus trees in the Garden where it grows to a larger size than in its native habitat.

ORDINARY MONTHLY MEETING.

31st October, 1928.

Dr. W. R. Browne, President, in the Chair.

Dr. Bertram Thomas Dickson, Cremorne, was elected an Ordinary Member of the Society.

The President announced that the Council had accepted, with regret, Dr. G. A. Waterhouse's resignation from the office of Hon. Treasurer and had elected Mr. Edwin Cheel as Hon. Treasurer for the remainder of the current Session.

The President offered the congratulations of members to Mr. E. A. Breakwell, B.Sc., on his appointment as Organizer of School Agriculture in the Education Department; and to Mr. W. R. B. Oliver on his appointment as Director of the Dominion Museum, Wellington, N.Z.

Candidates for Linnean Macleay Fellowships, 1929-30, were reminded that Wednesday next, 7th November, 1928, is the last day for receiving applications.

The Donations and Exchanges received since the previous Monthly Meeting (26th September, 1928) amounting to 9 Vols., 78 Parts or Nos., 7 Bulletins, 2 Reports and 1 Pamphlet, received from 65 Societies and Institutions were laid upon the table.

PAPERS READ.

1. New Australian Mydaidae (Diptera). By I. M. Mackerras, B.Sc., M.B., Ch.M.

2. Notes on Australian Diptera. No. xvii., By J. R. Malloch. (*Communicated by Dr. I. M. Mackerras.*)

3. Notes on *Corysanthes* and some species of *Pterostylis* and *Caladenia*. By Rev. H. M. R. Rupp, B.A.

4. Revision of *Hesthesis* (Cerambycidae) together with Description of a new Genus and Species of Buprestidae. By H. J. Carter, B.A., F.E.S.

5. The Life-history of *Doryanthes excelsa* (Corr.). Part i. Some Ecological and Vegetative Features and Spore Production. By I. V. Newman, M.Sc.

NOTES AND EXHIBITS.

Mr. David G. Stead exhibited a remarkable knitted sling obtained by him in Malacca (British Malaya). This sling was one of many used by Menangkabau Malays to frighten wild elephants away from young plantations of coconut. No means could be devised to keep the elephants from raiding the plantations and destroying the palms. But it was found that the elephants were "unnerved" by the whining sound made by rounded stones cast from these slings, followed by the smart stinging slap made by the stones on their sides, and made off again (frequently trumpeting with fear) into the jungle. Apparently it was the strange and, to the elephants, the inexplicable, sound, which caused the animals' fear; as the actual hurt by so small a missile (delivered with relatively little violence) on so huge a quarry, was but slight.

Mr. K. C. McKeown sent for exhibition, specimens of the hairy brown Cypress Pine aphis (*Dilachnus callitris*) with the following note: In his "Forest Insects of Australia" Mr. W. W. Froggatt originally recorded this aphis from Narrabri and Dubbo in 1921. In October, 1925, I found the same species at Leeton on a limited area of Cypress Pine scrub and forwarded specimens to Mr. Froggatt, which he figured, with further notes, in his "Forest Insects and Timber Borers." Although I had searched carefully from time to time, no further occurrence of this aphis was found until the 2nd August, 1928, when a heavy infestation was found over an extended area. The Cypress Pines (*Callitris robusta*) were very heavily infested and were wet and glistening from the quantity of honey dew and excrement which covered them. Aphides in all stages were present. The infestation increased in intensity for about a fortnight, at the end of which period the trunks of the large trees were massed with aphides descending and ascending, presenting the appearance of a brown moving mass.

About this period Aphides were also falling from the branches in great numbers and covered the ground under the trees, eventually climbing the trunks again. Under one tree on an area of not more than a foot square Aphides were massed to a depth of over two inches and here in less than 5 minutes I collected an "Eno's Fruit Salt" bottle full of the insects, simply gathering them up on the blade of a table knife. This will give an idea of how heavy the infestation was. About the end of the month the majority of Aphides appeared to migrate to the young Cypress Pines and almost immediately the old trees, which had been infested, burst into flower. At the time of writing (26th October, 1928) the old trees are practically free from Aphides, but young trees up to about four or five feet in height are still heavily infested.

In paddocks where Cypress Pines were infested considerable annoyance was caused to horses and cattle by the Aphides falling upon them from the trees and everywhere the stock could be seen rubbing themselves in an effort to free themselves from the irritation of the crawling Aphides. They also entered houses and other buildings, crawling up walls and along floors in a brown film. While the infestation was at its height the Aphides were heavily preyed upon by lady birds (*Verania frenata*) both in adult and larval stages, the trunks of the trees being liberally dotted with pupae. Larvae of the Green Lace Wing (*Chrysopa ramburi*) and the Vine Moth Bug also took heavy toll. Yellow-tailed Tits and White-eared Honey Eaters also found them an inexhaustible food supply.

Mr. E. Cheel exhibited specimens of a native "Buttercup" (*Ranunculus* sp.) showing further development and variation since that recorded at the meeting of this Society in May last. The seedlings not only showed intermediate characters in the dissections of the leaf but, in addition, pronounced pubescence in two of the plants, which is not apparent in either of the parent plants, as *R. rivularis* is perfectly smooth and glabrous whilst the leaves of the Lake George plants (the seed bearer) are sprinkled with a few scattered soft hairs. He also exhibited seedling plants of *Acacia dealbata* raised from seeds collected at Hobart, Tasmania, in January, and *Acacia mollissima* raised from seeds collected at the Gorge near Launceston, Tasmania, which are being closely studied for characters varying from those of the various forms of these two species as recorded for New South Wales. A number of specimens of *Acacia Baileyana* (Cootamundra Wattle) were also exhibited to show variation in hairiness; some were perfectly glabrous, some densely pubescent and others more or less hairy.

Mr. Gilbert P. Whitley exhibited a specimen of a Dragonet (*Callionymus macdonaldi* Ogilby) from Taree, New South Wales. The species has not hitherto been recorded from this State as the type, the only other specimen known, came from Moreton Bay, Queensland. This rare fish was caught recently by Dr. S. M. Ware and presented to the Australian Museum by Mr. T. C. Roughley.

Mr. W. W. Froggatt exhibited some Casuarina galls, made by an unknown Chalcid, from Euston on the Lower Murray.

Mr. A. J. Nicholson exhibited a series of lantern slides in illustration of the genus *Hesthesis* dealt with in the paper by Mr. H. J. Carter.

ORDINARY MONTHLY MEETING.

28th November, 1928.

Dr. W. R. Browne, President, in the Chair.

The President announced that the Council had re-appointed Miss Ida A. Brown, B.Sc., and Miss H. Claire Weekes, B.Sc., to Linnean Macleay Fellowships in Geology and Zoology respectively for a period of one year from 1st March, 1929.

Letters were read from Mr. E. Breakwell and Mr. W. R. B. Oliver returning thanks for congratulations.

The Donations and Exchanges received since the previous Monthly Meeting (31st October, 1928) amounting to 19 Vols., 159 Parts or Nos., 7 Bulletins, 4 Reports and 2 Pamphlets, received from 69 Societies and Institutions and 1 private donor were laid upon the table.

On completion of the purely formal business the papers set down for reading were taken as read and the meeting adjourned on account of the sudden death of Mr. R. H. Cambage, members passing the following resolution in silence:—

That the Members of this Society wish to place on record their deep sorrow and sense of personal bereavement in the death of their honoured and beloved friend and fellow member, Mr. R. H. Cambage, and desire to express their deep and sincere sympathy with the members of his family.

PAPERS TAKEN AS READ.

1. The Carboniferous Rocks between Glennies Creek and Muscle Creek, Hunter River District, N.S.W. By G. D. Osborne, B.Sc.

2. The Carboniferous Rocks of the Muswellbrook-Scone District, with special reference to their Structural Relations. By G. D. Osborne, B.Sc.

3. Notes on Australian Diptera. No. xviii. By J. R. Malloch. (*Communicated by Dr. I. M. Mackerras.*)

4. Notes on some Additions to the *Glossopteris* Flora in New South Wales. By A. B. Walkom, D.Sc.

5. The Physiography of the Wollondilly River Basin. By Frank A. Craft, B.Sc.

DONATIONS AND EXCHANGES.

Received during the period 1st December, 1927, to 28th November, 1928.

(*From the respective Societies, etc., unless otherwise mentioned.*)

ABERYSTWYTH.

Welsh Plant Breeding Station, University College of Wales.—Bulletin, Series H, No. 8, Seasons 1921-1928 (1928); "The Welsh Journal of Agriculture", i (1925); iv (1928); One reprint—"The Effect of Length of Day upon the Growth and Chemical Composition of the Tissues of certain Economic Plants", by M. A. H. Tincker (From *Annals of Botany*, xlii, No. clxv, Jan., 1928).

ACCRA.

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OXFORD.

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PERM.

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PHILADELPHIA.

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PLYMOUTH.

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PORTICI.

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PRAG.

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PRETORIA.

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PUSA.

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RENNES.

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RIO DE JANEIRO.

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SAN FRANCISCO.

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SARATOV.

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SEATTLE.

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SENDAI.

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SHARON.

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SOFIA.

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ST. LOUIS.

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STOCKHOLM.

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TASHKENT.

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TOKYO.

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TRING, Herts.

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TUNIS.

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VIENNA.

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WOODS HOLE.

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PRIVATE DONORS (and authors, unless otherwise stated).

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LIST OF MEMBERS, 1928.

Ordinary Members.

1927 *Albert, Michel François, "Boomerang", Elizabeth Bay, Sydney.
1905 Allen, Edmund, c/o Chief Engineer for Railways, Brisbane, Q.
1906 Anderson, Charles, M.A., D.Sc., Australian Museum, College Street, Sydney.
1922 Anderson, Robert Henry, B.Sc.Agr., Botanic Gardens, Sydney.
1899 Andrews, Ernest Clayton, B.A., F.G.S., Geological Survey, Department of Mines, Sydney.
1927 Armstrong, Jack Walter French, "Callubri", Nyngan, N.S.W.
1912 Aurousseau, Marcel, B.Sc.

1913 Badham, Charles, M.B., Ch.M., B.Sc., Bureau of Microbiology, 93 Macquarie Street, Sydney.
1888 Baker, Richard Thomas, The Crescent, Cheltenham.
1925 Barnard, Colin, M.Sc., Commonwealth Research Station, Merbein, Vic.
1919 Barnett, Marcus Stanley, c/o Colonial Sugar Refining Co., Ltd., O'Connell Street, Sydney.
1907 Benson, Professor William Noel, B.A., D.Sc., F.G.S., University of Otago, Dunedin, N.Z.
1926 Bingham, Mrs. J., B.Sc. (née Hall), Gosford, N.S.W.
1920 Blakely, William Faris, Botanic Gardens, Sydney.
1923 Bone, Walter Henry, 6 Deans Place, Sydney.
1926 Branch, Kenneth James Fergus, B.Sc., 99 North Steyne, Manly.
1912 Breakwell, Ernest, B.A., B.Sc., Department of Education, Box 33A, G.P.O., Sydney.
1927 Bredero, William Adrien Lewis, Box 127, Post Office, Orange, N.S.W.
1912 Brewster, Miss Agnes A., 481 Alfred Street, North Sydney.
1923 Brough, Patrick, M.A., B.Sc., B.Sc.Agr., "Kinross", Billyard Avenue, Wahroonga.
1921 Brown, Horace William, 871 Hay Street, Perth, W.A.
1924 Brown, Miss Ida Alison, B.Sc., Geology Department, The University, Sydney.
1911 Browne, William Rowan, D.Sc., Geology Department, The University, Sydney.
1928 Burgmann, Rev. Ernest Henry, M.A., St. John's Theological College, Morpeth, N.S.W.
1920 Burkitt, Professor Arthur Neville St. George Handcock, M.B., B.Sc., Medical School, The University, Sydney.
1921 Burns, Alexander Noble, "Lucerne", Lower Ferntree Gully, Victoria.
1910 Burrell, Harry, 19 Doncaster Avenue, Kensington.
1910 Burrell, Mrs. Harry, 19 Doncaster Avenue, Kensington.
1926 Buzacott, James Hardie, Meringa (private bag), via Cairns, North Queensland.

1901 Campbell, John Honeyford, M.B.E., Royal Mint, Ottawa, Canada.
1927 Campbell, Thomas Graham, Australian Museum, College Street, Sydney.
1905 Carne, Walter Mervyn, Government Botanist, Perth, W.A.
1890 Carson, Duncan, c/o Winchcombe, Carson, Ltd., Bridge Street, Sydney.
1903 Carter, Herbert James, B.A., F.E.S., "Garrawillah", Kintore Street, Wahroonga.
1899 Cheel, Edwin, Botanic Gardens, Sydney.
1924 Chisholm, Edwin Claud, M.B., Ch.M., Comboyne, N.S.W.
1920 Clarke, Harry Flockton, c/o Colonial Sugar Refining Co., Ltd., Rarawai Mill, Ba River, Fiji.
1901 Cleland, Professor John Burton, M.D., Ch.M., The University, Adelaide, S.A.
1920 Cooper, Mrs. A. G. S., B.Sc. (née Henry), Ogilvie Street, Denman, N.S.W.
1908 Cotton, Professor Leo Arthur, M.A., D.Sc., Geology Department, The University, Sydney.

* Life Member.

1928 Craft, Frank Alfred, "Kyla", 24 Fourth Street, Ashbury.
1900 Crago, William Henry, M.D., 185 Macquarie Street, Sydney.
1925 Cunningham, Gordon Herriot, Department of Agriculture, Fields Division, Plant Research Station, P.O. Box 240, Palmerston North, N.Z.

1885 David, Sir Tannatt William Edgeworth, K.B.E., C.M.G., D.S.O., B.A., D.Sc., F.R.S., Sherbrook Road, Waitara.
1925 de Beuzeville, Wilfred Alexander Watt, Tumut, N.S.W.
1928 Dickson, Bertram Thomas, B.A., Ph.D., Chief of Division of Economic Botany, Commonwealth Council for Scientific and Industrial Research, Canberra, F.C.T.
1881 Dixson, Thomas Storie, M.B., Ch.M., 215 Macquarie Street, Sydney.
1927 *Dixson, William, "Merridong", Gordon Road, Killara.
1921 Dodd, Alan Parkhurst, Prickly Pear Laboratory, Sherwood, Brisbane, Q.
1923 Drummond, Miss Heather Rutherford, "Ala", 15 Watson Street, Neutral Bay.
1926 Dumigan, Edward Jarrett, Boys' State School, Toowoomba North, Toowoomba, Queensland.
1928 Durrell, Miss Eileen Leys, B.Sc., 345 Bridge Street, Drummoyne.
1920 Dwyer, Rt. Rev. Joseph Wilfrid, Bishop of Wagga, Wagga Wagga, N.S.W.

1914 Enright, Walter John, B.A., West Maitland, N.S.W.

1908 Flynn, Professor Theodore Thomson, D.Sc., University of Tasmania, Hobart, Tasmania.
1927 Francis, William Douglas, Botanic Gardens, Brisbane, Queensland.
1920 Friend, Norman Bartlett, 48 Pile Street, Dulwich Hill.
1911 Froggatt, John Lewis, B.Sc., Department of Agriculture, Brisbane.
1886 Froggatt, Walter Wilson, F.L.S., Young Street, Croydon.
1920 Furst, Herbert Charles.

1927 Garde, Miss Mary Lee, "Wavertree", Kurraba Road, Neutral Bay.
1912 Goldfinch, Gilbert M., "Lyndhurst", Salisbury Road, Rose Bay.
1928 Goulston, Miss Daphne Lydia, B.Sc., "Eden", Lang Road, Centennial Park, Sydney.
1899 Grant, Robert, 24 Edward Street, Woollahra.
1923 Gray, Archibald James, "Glendyne", Augusta Street, Concord.
1911 Greenwood, William Frederick Neville, F.L.S., F.E.S., c/o Colonial Sugar Refining Co., Ltd., Lautoka, Fiji.
1910 Griffiths, Edward, B.Sc., Department of Agriculture, 136 Lower George Street, Sydney.
1901 Gurney, William Butler, B.Sc., F.E.S., Department of Agriculture, George Street North, Sydney.

1911 Hacker, Henry, F.E.S., Queensland Museum, Bowen Park, Brisbane, Q.
1925 Hale, Herbert Matthew, South Australian Museum, Adelaide, S.A.
1909 Hall, Edwin Cuthbert, M.D., Ch.M., George Street, Parramatta.
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1910 Wymark, Frederick, 89 Castlereagh Street, Sydney.

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1923 Wilson, Professor J. T., LL.D., M.B., Ch.M., F.R.S., Department of Anatomy, the New Museums, Cambridge, England.

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NOTES ON AUSTRALIAN COLEOPTERA, WITH DESCRIPTIONS OF NEW SPECIES. Part i.

By Charles Oke.

[Read 28th March, 1928.]

Staphylinidae.

Dabra sulcicollis, n. sp.

Testaceous; head and elytra dingy-brown; prothorax castaneous; first, second and eleventh joints of antennae and tarsi flavous, intermediate antennal joints infuscated. Clothed with pale ashen pubescence, tips of abdominal segments with a row of moderately long hairs.

Head strongly transverse, narrowed in front, indistinctly punctured. Antennae with first joint large, second about half length of first, thin at base, thickened near apex, third to tenth transverse, increasing in width, eleventh as long as preceding four combined, rounded at apex. Thorax transverse, base bisinuate, with the hind angles produced and having three or four stout setae; a large mediobasal impression continued to apex; fine confluent punctures. Elytra strongly transverse; posterior margin quadri-sinuate with the lateral angles produced; sculpture finer and more indistinct than on pronotum. Abdomen tapering, smooth and shining on basal joints, apical and subapical rather closely punctured. Under surface closely punctured. Length, 3·80 mm.

Hab.—Victoria: Gypsum, in nests of *Iridomyrmex nitidus* (C. Oke).

Distinguished from the previously described species by the impression on pronotum. Viewed from some directions this appears to be an isolated round fovea somewhat obliquely impressed on the pronotum, but when viewed obliquely from the sides it appears as a medial sulcus dilated near the base.

Type in author's collection.

Quedius belgravensis, n. sp.

♂. Dingy reddish-brown, in parts infuscated; legs and tips of abdominal segments paler, head and pronotum black, elytra and mandibles pale testaceous, two basal joints of antennae (the others much infuscated), palpi and tarsi flavous. Elytra, abdomen and sternum rather thickly clothed with pale adpressed pubescence; sides of head, prothorax and abdomen with scattered long black hairs.

Head, excluding neck, transverse, convex, rounded on sides; eyes large, same length as inter-antennary space; two punctures at base of each antenna, a small puncture near eye, and a larger one between eye and neck. Antennae with first joint long, second slightly longer than third, fourth smaller, fifth and sixth quadrate, seventh to tenth transverse, eleventh ovate-acuminate, lightly incurved at apex. Prothorax a little wider than long, widest near base; with two punctures nearer apex than usual. Elytra quadrate, with rather close

distinct punctures. Abdomen more closely punctate than elytra; under surface of apical segment with three V-shaped notches, subapical segment rather deeply emarginate in centre. Front tarsi with four basal joints much dilated; intermediate with basal joint swollen, longer than next three combined, and with a conspicuous V-shaped black comb on the lower surface, composed of 25 teeth. Length, 5 mm.

Hab.—Victoria: Belgrave (C. Oke) in July, under rotting leaves.

In many respects close to the description of *Quedius cordatus* Lea, but the elytron is closely punctate and the abdomen very closely so; also the comb of the tarsus is very different. The comb is V-shaped and is placed obliquely on the tarsi with the open end towards the base. The teeth at the closed end are very closely packed and are smaller than the teeth at the other end; as a result they are difficult to count, but I believe there are twelve teeth on either side and one at apex. The apical joint of the palpi is rather short, but is decidedly thicker at base than apex. On the elytra, behind the scutellum there is a vague infuscated blotch.

Type in author's collection.

Procirrus ferrugineus Lea.

I have taken twelve specimens of this species at Caulfield, Coburg, Sunshine and Melton; the colours are constant and as described by Lea. The mandibles are much like those figured by Lea for *Pinophilus semiopacus*, except that the tooth is not so deeply notched at its apex. The apex is cut off obliquely and lightly emarginate, the deepest part of the emargination being nearer the outside than the inside.

The male, not previously described, has the front tibiae very slightly wider than the female, and has a V-shaped notch on the under surface of the preapical segment of abdomen, but otherwise agrees with the female.

Allotype in author's collection.

Suniopsis cribripennis Lea.

Eight specimens of this species before me show that the type specimen was immature or not of the normal colour. The palest specimen is reddish-castaneous, three are dark castaneous, diluted with red along the sides, three are piceous and one is black. It would appear that the normal colour is almost black, in parts, particularly base of elytra, diluted with red, mandibles, palpi and antennae reddish-castaneous, legs flavous, with base of femora and middle of tibiae infuscated.

The palpi show that *Suniopsis* and *Hyperomma* should be merged, as suggested by Lea, because the apical joint is apparently movable, at least in this species. Four specimens have the apical joint distinctly protruding in both palpi, one has just the extreme tips of both palpi just discernible, two have only one each visible and one has both tips concealed.

♂. With the subapical segment having a fairly wide lunate excision. The front tarsi same width as in ♀.

Allotype ♂ in author's collection.

Hab.—Victoria: Fern Tree Gully (in May), Belgrave (in March and May), Evelyn (in June), Emerald (August and November), Warburton (January) (C. Oke), found in tussocks and rotting leaves.

Hyperomma labrale Lea.

I have taken a ♀ of this species at Warburton, Vic. It agrees in all respects with the description, but is larger, 12½ mm. as mounted, and has the apical segments telescoped.

Hyperomma atra, n. sp.

♂. Black; labrum, mandibles and apex of abdomen reddish, tibiae, palpi, first, second and eleventh joints of antennae testaceous, intermediate joints infuscated, femora watery-flavous. Head, thorax and elytra sparingly, abdomen densely, clothed with long black hairs.

Head subquadrate, suddenly constricted in front of eyes, hind angles rounded off; labrum with a U-shaped excision in middle; mandibles very acuminate to apex, with a small, but distinct, blunt tooth near base; eyes large, invisible from below; with large round sparse punctures on dorsal surface, becoming rather dense on ventral. Antennae with joint one long, three longer than two or four, four-ten decreasing in length, eleven briefly ovate. Prothorax cylindrical, with an irregular semidouble row of punctures on either side of centre and a few scattered small punctures. Elytra slightly longer than wide, with large round close punctures. Abdomen densely covered with large punctures on both surfaces; apical ventral segment with a deep U-shaped excision, preapical depressed near margin and lightly emarginate. Legs rather long, anterior tarsi thin. Length, 7½ mm.

Hab.—Victoria: Carrum (C. Oke).

The mandibles are longer and thinner, with the tooth smaller, not so acuminate and nearer base than in following species. The labrum is different and the head and abdomen are more closely punctate.

Type in author's collection.

Hyperomma pallipes, n. sp.

♂. Black; mandibles and prothorax red, the latter with an elongate blotch on disc and sides black; two apical segments of abdomen and apex of palpi diluted with red; labrum, two basal joints of antennae and legs testaceous; antennae dingy-brown, apical joint paler. Nitid. Head, thorax and elytra sparsely, abdomen, legs and antennae rather closely clothed with moderately long pubescence; antennae also with fine dense pubescence; sides of head, elytra and abdomen with long straggling hairs.

Head oblong-ovate with a large neck; with large and numerous irregularly distributed punctures; labrum with a V-shaped notch in middle and an oblique lunate excision on either side, leaving a blunt tooth between; mandibles long and acute, with a distinct tooth towards base, the base swollen; eyes large, invisible from below; under surface nitid and almost impunctate on disc, but with large punctures on base and sides. Antennae with first joint large, third about half the length of first, twice length of second, a little shorter than fourth, fourth to sixth decreasing, seventh to tenth equal, eleventh a little longer, rounded at apex. Prothorax oblong, slightly wider at apex than base, angles rounded off, margined on basal half of sides, an irregular double row of moderate punctures on either side of middle and numerous smaller ones distributed about. Elytra short, with fairly dense, large punctures, the surface between finely shagreened; a large bristle at humeral angles. Abdomen gradually tapering, finely shagreened and a few small punctures; subapical segment with a

deep V-shaped notch on under surface. Legs rather long; front tarsi thin. Length, 7·25 mm.

Hab.—Victoria: Grampians, from moss in November (C. Oke).

Mr. Lea has kindly compared my specimen with his types and I am indebted to him for the following note: "Differs from *bryophilum* in having shorter and darker antennae, shorter jaws with inner tooth smaller, prothorax less dilated in front, with dark sides, rows of punctures on each side of middle smaller and more numerous, elytra with denser and smaller punctures and abdomen darker. Nearer *pictipes* but head darker, tibiae not bicoloured and punctures of prothorax and elytra denser."

Type (unique) in author's collection.

Pselaphidae.

Faronini.

SAGOLA VENTRALIS, n. sp.

♂. Reddish-castaneous; legs and palpi paler. Rather closely clothed with short yellowish pubescence.

Head small, with two distinct interocular foveae; lightly impressed between antennal tubercles. Antennae extending to basal fourth of elytra; joint one thick, as long as two-three combined, three smaller than two, four-eight subequal, nine-ten larger, transverse, eleven same width, shortly ovate. Prothorax slightly longer than wide, widest about middle, much narrowed to apex, less strongly to base; with a transverse prebasal impression, which is dilated forward in middle, and connecting three foveae; sides obliquely impressed; with fine sparse punctures, base with a row of larger punctures. Elytra slightly longer than wide, lightly narrowed to base, humeral angles widely rounded; subsutural striae with four small foveae near base; discal stria represented by two rather large impressions behind base and a groove, which is continuous to apex; two large impressions between sutural and discal striae, a faint groove near margins; fine scattered punctures. Abdomen lightly dilated to fourth segment, apex pointed; strongly margined; under surface lightly flattened along middle, third segment with a longitudinal process on its apical two-thirds. Metasternum excavated posteriorly; lightly carinated across anterior margin of excavation. Middle trochanters with a sharp tooth, hind trochanters compressed and produced into a sub-cuneiform process.

♀. Differs in having under surface of abdomen convex and without process, and the trochanters unarmed. Length 1·60 mm.

Hab.—Victoria: Carrum (C. Oke).

The eighth joint of the antennae is irregular and viewed from some directions appears to be the smallest joint. The process on abdomen, when viewed from the side, is seen to start near the base of the third segment and increase in height to the apex of that segment, where it is truncated.

Apparently, from the description, this species is close to *S. australiae*, of which the female only was described, but differs, *inter alia*, in the elytral sculpture. In the present species, the sutural and discal striae are continuous to apex, with two impressions between.

Type in author's collection.

SAGOLA FILIXICOLA, n. sp.

♂. Dark reddish-castaneous. Thickly clothed with long reddish-yellow setae. Head with a large oval fovea in middle, open in front and narrowly separating

antennal tubercles, the latter with a narrow sulcate impression on each from base to near apex. Antennae robust, joint 1 thick and long, 2 much smaller, 3 smallest, 4-11 gradually increasing in width, 8-10 strongly transverse, 11 obliquely produced on inner side of apex. Prothorax transverse, strongly rounded on sides; with a large medio-basal fovea and a smaller obliquely impressed one on each side; with a few scattered punctures. Elytra with sutural striae distinct, discal with a round fovea at base and a larger one behind, the striae traceable to beyond middle, a small round fovea on base between the striae; fine sparse punctation. Abdomen increasing in width to fourth segment, strongly margined; punctures as on elytra; under surface with a flattened impression on apex of third and sixth segments. Metasternum impressed posteriorly. Posterior trochanters compressed and produced into a fairly acute cuneiform process. Length, 2·40 mm.

Hab.—Victoria: Gembrook (C. Oke), in a fern gully.

A large robust species. It is more robust and with longer and denser clothing than any other species known to me. The medial fovea on the pronotum is unusually large, and, when viewed obliquely from behind, it appears to occupy about one-third of the total area of that segment.

Type in author's collection.

SAGOLA TRICOLOR, n. sp.

Piceous; antennae and femora paler, elytra reddish, tibiae (apices infuscated), tarsi, mandibles and palpi flavous. Clothed with fine pale pubescence, with a few scattered long hairs.

Head small, with three foveae, two interocular open in front, and one in frontal impression; antennal tubercles not very prominent; a few small punctures. Mandibles prominent with four minute denticulations near base. Antennae reaching middle coxae; joint one large, as long as next two combined, two same width but shorter, three small, four to eight subequal, nine to eleven forming a light club, eleven slightly pointed. Prothorax slightly longer than wide, with an irregular transverse impression at base, joined with the medio-basal fovea, sides obliquely impressed. Elytra longer than wide; sutural and discal striae interrupted near base by small impressions, discal striae continuous to apex, between sutural and discal striae with three round impressions in a longitudinal line, a groove near margin. Abdomen same length as elytra, lightly dilated to fourth segment, apex somewhat pointed. Length, 1·10 mm.

Hab.—Victoria: Warburton (C. Oke).

The colours, if constant, will easily lead to the identification of this species, but otherwise the elytral sculpture is distinctive, as also is the head.

Sagola misella Sh. must be regarded as the genotype of *Sagola*, as Sharp described the genus from a dissected specimen of that species. In his formal diagnosis he gives as one of its characters "mandibles without teeth on the inner edge", but, as *S. tricolor* has all the other characters given, I do not think its dentate mandibles should exclude it.

Type (unique) in author's collection.

Euplectini.

LIMONIATES CRIBRATUS, n. sp.

♂. Dark castaneous-brown; antennae, palpi (tip infuscated) and legs flavous. Moderately clothed with short ashen pubescence. With close distinct punctures becoming a little finer on abdomen.

Head about as long as width at base. Antennal tubercles small but prominent Antennae with joint 1 large, 2 smaller but larger than 3, 3-8 small, 9-10 larger, transverse, subequal, 11 largest, sharply pointed, length of three preceding combined. Prothorax subquadrate, widest about middle, much narrowed to apex; with a rather deep transverse impression at basal third, a shallow longitudinal impression from apex, not quite reaching transverse impression, foveate near sides. Elytra longer than wide, sides parallel; sutural striae distinct, discal striae short, base with six foveate impressions. Abdomen with a transverse medio-basal impression; under surface lightly flattened, a subapical impression and apex slightly produced. Anterior and intermediate femora rather strongly inflated, posterior lightly inflated. All the tibiae lightly inflated to about apical third, thence obliquely narrowed to apex, where the middle ones are obtusely spurred.

♀. Similar to ♂, though slightly narrower, legs not so inflated and the under surface of abdomen lightly convex. Length, 1 mm.

Hab.—Victoria: Frankston (C. Oke) in tussocks.

Type in author's collection.

PLECTOSTENUS ORIENTALIS, n. sp.

♂. Very dark reddish-castaneous. Clothed with minute pale pubescence.

Head small, truncate in front, rounded on sides, constricted behind; with three interocular foveae all opening in front, and an oblique impression near each antennal tubercle; indistinctly punctate. Antennae long, joints 2-9 cylindric, 9 wider at apex than base, 10 a little wider than 9, 11 ovate-acuminate. Thorax convex, with a conspicuous transverse groove, foveate on sides and at centre, the central fovea dilated forward; punctures as on head. Elytra longer than wide, sutural striae foveate at base and continuous to apex, first dorsal stria very faint, second with a large fovea at base, the stria itself well impressed at base, but becoming obsolete near middle; punctures very indistinct and surface rougher than on pronotum. Abdomen with punctures larger and more distinct than on pronotum. Under surface with moderate confluent punctures on parts, larger on head than elsewhere. Ventral surface of head and prosternum longitudinally carinated. Metasternum widely depressed. Fifth and sixth ventral segments with a shallow depression, apex of abdomen bisinuate. Anterior trochanters obtusely armed, tibiae finely spinose at apex. Length, 2 mm.

Hab.—Victoria: Bendigo, in nest of *Chalcoponera*; N. S. Wales, in nest of *Euponera lutea* (A. M. Lea).

In appearance very like *P. gracilicornis*, but larger, with the head and sculpture of elytra somewhat different. There are vague traces of a longitudinal impression on disc of pronotum, but these are faint and not visible when looked at from some directions.

Brachyglutini.

BATRAXYS TRIFOVEATA, n. sp.

Pale castaneous. Conspicuously clothed with short pale pubescence. With indistinct punctures.

Head with a strong transverse impression in front and two interocular foveae. Antennae with joint 1 thicker but scarcely longer than 2, 3 longer, 4-8 moniliform, 9 smallest, 10 transverse, 11 largest, truncate-ovate. Prothorax widest in front of middle where sides are strongly rounded, much narrowed to apex,

obliquely cut away towards base; a small medio-basal fovea and one on either side. Elytra transverse, base quadrifoveate, shoulders obliquely raised; sutural striae indistinct, discal wanting. Abdomen with two short carinules at base, widely separated, the space between being half width of abdomen. Metasternum rather widely impressed, sides of impression carinate posteriorly. Legs unarmed. Length, 1·90 mm.

Hab.—Victoria: Eltham (C. Oke), in nest of *Iridomyrmex.*

The unique specimen of this species is possibly a ♂, the metasternum being widely impressed, but the abdomen is scarcely flattened. The genus has been characterised as having only the medio-basal fovea on the prothorax, but as the present species agrees in all other generic characters, I have not thought it advisable to propose a new genus for it, simply because it has the two lateral foveae. Compared with *B. armitagei*, as identified by Mr. Lea, the present species is paler, duller and wider and with very conspicuous clothing.

Type (unique) in author's collection.

RYBAXIS MONSTRABILIS, n. sp.

♂. Pale castaneous; legs and eleventh joint flavous, eighth joint infuscated, ninth and tenth black. Sparsely clothed with short pale pubescence.

Head longer than wide, convex, smooth and shining on vertex, a few punctures in front between antennae; with two small interocular foveae. Antennae long, joint 1 large, 2 smaller, 3-4 subequal, 5 longer and wider, as long as 3-4 combined, 6-7 subequal, 8 smallest, 9-10 large, increasing, 11 largest, strongly curved, excavate on lower surface. Prothorax lightly transverse, widest at apical third, suddenly narrowed to apex; each side with a fovea, the two connected by a strong impression, which is bent backwards, but scarcely foveate, in centre; strongly strigose in front of impression. Elytra about as wide at apex as length down suture, much attenuated to base, apical margin strongly produced nearer suture than margin; sutural striae distinct, discal striae abruptly ending near margin; with a fine scattered punctation, becoming coarser posteriorly. Abdomen with a small medio-basal node and two short diverging striae; under surface with first segment raised between hind coxae and then strongly impressed, margin of second recurved cephalad in middle, thence to apex with a deep impression, apex lightly produced. Meso- and meta-sternum strongly sulcate. Anterior trochanters at base and anterior femora at base with a minute sharp tooth. All the femora inflated in middle, the anterior slightly more so than the intermediate, the posterior much less; the intermediate impressed (scarcely notched) near base on lower surface. Anterior tibiae strongly dentate at apical third, thence emarginate to apex; intermediate thickened to apical third, thence obliquely narrowed to apex, the apex notched, leaving an obtuse tooth; posterior lightly curved.

♀. Slightly smaller than the ♂, with the ventral surface of abdomen convex and without the recurved plate on second segment; the margin of elytra not produced and legs simple. Length, 2·50-2·70 mm.

Hab.—Victoria: Fern Tree Gully (C. Oke), in July and October.

A fine large species with strigose pronotum, differing in several respects from the other described species having that character. The antennae are peculiar, with joints 9-11 cut away underneath, where they are highly polished. The apical joint is much as figured by Lea for his *acanthosterna* (= *atriceps* Macl.), but is more curved. When viewed from the sides the ninth and tenth joints are

seen to be very thin. The males are very pale and appear to be somewhat immature, but the ninth-tenth joint is absolutely black in all examples, so this may be the mature colour.

Type in author's collection.

RYBAXIS MELANOCEPHALA, n. sp.

♀. Reddish-castaneous; head and 9th and 10th joints black, legs and palpi almost flavous. Moderately clothed with short pale pubescence.

Head widely but shallowly impressed between antennae and with two round interocular foveae; moderate sparse punctures, becoming much closer in front. Antennae reaching middle coxae, joint 1 longer than next two combined, 2 stout, 3-4 subequal, 5 longer, 6 shorter, 5, 7 same length as 3, 8 smallest, 9-10 increasing, 11 largest, ovate-acuminate, longer than 9-10 combined. Prothorax transverse, sides evenly rounded; three prebasal foveae connected by a distinct arcuate impression; striolate in front of groove, behind with a few fine punctures. Elytra scarcely as long as width at apex, narrowed to base; humeral region slightly raised; subsutural striae interrupted near base by a foveate impression, discal striae arcuate and distinct to near apex, foveate at base; very finely and sparsely punctured. Abdomen with medio-basal impression; punctures as on elytra. Metasternum rather deeply excavated posteriorly. Length, 2·10-2·20 mm.

Hab.—Victoria: Daylesford, in moss (C. Oke).

Described from 7 females obtained in October and February. The head and two joints of antennae black, the strigose pronotum and short pale clothing should make this an easy species to identify.

RYBAXIS DELECTABILIS, n. sp.

♂. Sternum and abdomen (apex excepted) black; fourth-tenth joints of antennae deeply infuscated, head and pronotum dark obscure brown, disc of elytra and apex of abdomen bright reddish-castaneous, legs, palpi and joints 1-3 and 11 pale reddish-castaneous. Clothed with moderately long yellowish pubescence.

Head with a large depression in front between antennae and two large round interocular foveae; with fine scattered punctures becoming closer and coarser in front. Antennae with joint 1 as long as next two combined, 2 short, 3 longer than 2, thin at base, increasing to apex, 4-8 produced on inside over entire length, 4 larger than 2, 5 larger than 4, 6-7 equal, larger than 5, 8 shorter but same width, 9-10 larger, subequal, 11 truncate-ovate, lightly cut away on inside near apex; joints 4-10 finely rugose. Prothorax transverse, strongly rounded on sides; with a large fovea on either side connected by a strongly impressed curved line, central fovea obsolete. Elytra lightly transverse, with sutural striae distinct and discal widely impressed at base and traceable to apical declivity; epipleural furrow very distinct; with fine distinct but scattered punctures. Metasternum shallowly impressed in front, becoming deeper and wider behind. Ventral surface of abdomen with a small node on base of fourth segment, apex with an elongate fovea. Intermediate trochanters finely dentate. Anterior tibiae minutely dentate before apical third.

♀. Differs from the ♂ in having antennae much thinner, with the joints not produced inwards and only joints 8-10 dark; abdomen without node and non-foveate; the trochanters and tibiae non-dentate. Length, 2·20 mm.

Hab.—Victoria: Carrum and Frankston (C. Oke).

The antennae of this very distinct species are peculiar in the ♂; the joints appear to be a different shape according to the position from which they are viewed, as in *parvidens*, *quadrituberculata* and *quadriceps*. When viewed from the side they are seen to be as described above. The colours of the antennae in the two sexes appear to be constant in all the specimens before me, though some have the abdomen brownish, not black; these are probably immature.

Types in author's collection.

RYBAXIS KINGI, n. sp.

Castaneous; three apical joints of antennae infuscated. Clothed with short pale pubescence.

Head with two round interocular foveae, and deeply impressed between antennae. Antennae with joint 1 long, 2 not so wide and less than half length of 1, 3 thin, longer than 5, 5 longer than 4 or 6, 7 same as 5, 8 smallest, 9 large, 10 larger, 11 largest, oblong-ovate. Prothorax with sides strongly rounded, widest near middle; transverse furrow biarcuate, medial fovea very small, lateral moderate; with fine scattered punctures. Elytra with sutural striae foveate at base and distinctly impressed to apex, discal well impressed to apical declivity; shoulders obliquely raised; with fine fairly close punctures. Abdomen with two short divergent carinules, fasciculate between; under surface flattened, with a small impression near apex. Metasternum rather deeply sulcate. Four front femora lightly inflated. Anterior tibiae feebly spinose near apex, intermediate with a long curved spur at apical fifth.

♀. Similar to ♂, but differs in having abdomen convex, tibiae unarmed and the club thinner. Length, 1·50 mm.

Hab.—Victoria: Eltham (C. Oke).

Very like *harti* in size and general appearance even as to the apical joints of antennae being infuscated, but tibiae differently armed. Schaufuss and Lea describe *isidorae* as having the last joint of antennae pale and the front tibiae noticeably armed. Smaller than *sanguinipennis*, which is also different in colour and has apex of abdomen sulcate. In *otwayensis* the abdomen is excavate and has a recurved plate on lower surface.

Type in author's collection.

RYBAXIS BREVIS, n. sp.

♂. Reddish-castaneous. Rather closely clothed with short pale pubescence.

Head small with five foveae, 2 between eyes, 2 at bases of antennae and 1 in depression between antennae. Antennae with joint 1 large, as long as next two combined, 3 smaller than 2, 5 longer than adjacent joints, 8 smallest, 10 subtrapezoidal, 11 largest, truncate-ovate. Prothorax transverse, sides widely rounded; with three distinct foveae at base; rather close fine punctures. Elytra transverse, with 6 basal impressions; sutural striae distinct, discal distinct to apical declivity, strongly curved; shoulders distinctly raised; punctures a little sparser than on pronotum. Abdomen with two divergent carinules reaching about apical third of basal segment; under surface flattened, apex foveate. Metasternum widely impressed. Intermediate trochanters dentate. Intermediate tibiae notched at apex, leaving a short spur.

♀. Differs from the male in having thinner antennae, abdomen convex underneath and apex non-foveate, trochanters and tibiae not armed. Length, 1·10-1·20 mm.

Hab.—Victoria: Warburton and Belgrave (C. Oke).

A small species related to *electrica* King, but the spur on intermediate tibiae will distinguish it from that and other described species. There are indications of the transverse impression at base of thorax, but these are faint and invisible from some directions.

RYBAXIS LEAI, n. nom.

Rybaxis villosa Lea (nom. praeocc).

The name *villosa* was preoccupied, by Raffray (1904) for a species from Tonkin, when proposed by Lea and so it is necessary to alter the later name.

RYBAXIS STRIGICOLLIS Westw.

(= *R. longipilosus* Wilson.)

Having examined well over 200 specimens of this species I feel confident of the above synonymy. The only differences that were noted in the description of the latter species were in the antennae, viz.: *strigicollis* with the ninth and tenth joints of the antennae black and the eleventh "rather strongly bent"; *longipilosus* with unicoloured antennae and the apical joint "a little bent." In a series in front of me (74 specimens, including some cotypes of *longipilosus*) there is every gradation in colour of the ninth and tenth joint, from flavous (immature) to black; also the apical joint varies a little in shape, though the apparent shape of this joint depends on the angle from which it is viewed.

Specimens have been taken that were almost white and kept alive in captivity until they reached the mature colour. The darkening of the antennal joints is very gradual and apparently in some individuals they never really become black, but remain at most infuscated. This species is very common around Melbourne and is widely spread in Victoria, as I have taken it from such widely spread localities as: Grampians, Bendigo, Lorne, Wandong, Mornington and Traralgon. It also occurs in New South Wales and Tasmania.

RYBAXIS QUADRICEPS Westw.

Lea has drawn attention to a specimen in the Howitt collection which he thought had been correctly identified as this species, and I think there can be no doubt that this determination is correct. The species is fairly common around Melbourne, but I have not taken it associating with ants and it certainly cannot be considered a myrmecophile even if an odd specimen has been found near, or with, ants. Neither can *R. strigicollis* be so regarded. Both species live in grass tussocks and moss.

Hab.—Victoria: Fern Tree Gully, Emerald, Warburton, Carrum, Frankston (C. Oke).

EUPINOPSIS UNICLAVATA, n. sp.

♂. Castaneous. Clothed with fairly short pubescence, a few longer reddish hairs on abdomen and antennae.

Head large, longer than wide, attenuated in front; the vertex raised in front forming a ridge between the antennae, behind a ridge a large depression and two small round interocular foveae; the front concavely declivous, with the anterior margin lightly reflexed; mandibles quadri-dentate; with scattered microscopic punctures. Antennae with joint 1 long, 2 about half size of 1, 3-5 much smaller, subequal, 6-7 larger, subglobular, equal, 8 still larger, 9 smallest, quadrate,

10 narrow, transverse, 11 very large, truncate ovate; 6-8 each with a little group of papulae on inner surface, each papula with a long luteous seta, 10-11 covered with the setiferous papulae. Prothorax transverse, narrowed to apex, widely rounded on sides, with a small medio-basal fovea and the base with a line of small punctures. Elytra large, narrowed to the base; sutural striae deeply impressed to apex; discal rather widely impressed at base, but becoming obsolete about middle; with a few scattered indistinct punctures. Abdomen with first segment large; ventral surface with a large transverse impression at apex. Metasternum with a wide, but not deep impression. Legs long. Length, 1·50 mm.

Hab.—Victoria: Belgrave (C. Oke).

The head and antennae of this species are both remarkable and distinctive. The impression on the head, behind the inter-antennal ridge, appears to be feebly divided into two separate impressions when viewed from behind, but from other directions it appears to be entire. The antennal club is formed entirely by the last joint, which is very large.

Type in author's collection.

Eupinolus, n. gen.

Head rather large, longer than wide, front impressed, two interocular foveae. Antennae irregular, club formed by the last joint only. Prothorax cordate, with a medio-basal fovea and one on either side below the disc; the base with a fine transverse groove, which is more or less punctate. Elytra without basal foveae or discal striae, sutural striae rather faint. Abdomen rather long, margined, ventral surface with segment 1 hidden under the metasternum, but just perceptible between the coxae, 2 large, 3, 4, 5 short, 6 larger. Metasternum large. Anterior and intermediate coxae contiguous; posterior distant. Legs of moderate length.

The transverse groove of the prothorax is right on the base and is rather fine, with the medio-basal fovea touching it, but the lateral foveae, which are not visible, or scarcely so, from above, are some distance from it. The genus will be distinguished from *Eupines* and *Eupinoda* by the fovea on prothorax and the single jointed club; and from *Eupinopsis* by the absence of basal foveae and discal striae on the elytra.

Genotype, *E. lucifugus*.

Eupinolus lucifugus, n. sp.

♂. Reddish-castaneous. Clothed with moderately long semidecumbent pubescence, a few longer hairs on abdomen. With faint indistinct punctures.

Head rather large, a little longer than wide, anterior margin sinuate and reflexed; with a large deep impression in front, and two small rounded interocular foveae. Antennae long, joint 1 large, 2 a little narrower, much shorter, 3-6 subequal, smaller than 2, 7 large, two and three-fourths as wide as 6, 8 a little smaller than 7, subglobular, 9 smallest, 10 just perceptibly larger than 9, 11 large, same width as 7, truncate-ovate; seventh and eighth joints with small papulae bearing long yellowish setae on inner surface. Prothorax subquadrate, rounded on sides; medio-basal fovea small. Elytra fairly large, sutural striae distinct to apex. Abdomen with first segment large, the following joints decreasing and bent downwards; ventral surface with 3-5 segments shortened down middle, the apex slightly produced underneath and lightly impressed. Metasternum with a large deep impression, which is subcarinate on the sides. Legs long, all the femora lightly inflated in middle, posterior tibiae curved inward.

♀. Differs in being smaller; joints 7 and 8 of antennae not being inflated and the apical joint smaller, though still of large size; ventral surface of abdomen more convex and the metasternum not so widely impressed. Length, ♂, 1·40; ♀, 1·15 mm.

Hab.—Victoria: Fern Tree Gully and Warburton (C. Oke) under deeply embedded logs.

The impression on the head is peculiar and appears of different shape from each angle of view. Viewed from behind it appears as a large irregular depression, deep behind and shallow in front, with an oblique extension behind each antenna. From the sides it appears to be open in front, but divided in its middle by a swollen ridge. The peculiar formation of the ♂ antennae will easily lead to its identification; in the female the seventh joint is longer, but not wider, than the adjacent joints.

Types in author's collection.

Eupinolus parasitus, n. sp.

♂. Reddish-castaneous. Moderately clothed with fine yellowish depressed pubescence, with distinct patches of golden pubescence on sides of pro-, meso- and metasternum near the coxae.

Head moderate, narrowed in front, hind angles rounded; a large impression between antennae and two fairly large round interocular foveae; with sparse fine punctures. Antennae with joint 1 longer and wider than 2, 2 larger than 3, 3-6 subequal, 7 inflated, longer and wider than 2, 8 same as 6, 9-10 slightly increasing, 11 largest, truncate-ovate. Prothorax widest at apical third, suddenly narrowed to apex, arcuately narrowed to base; with a round fovea and a line of punctures at base. Elytra with sutural striae distinct to near apex; punctures as on head. Metasternum widely and rather deeply excavated. Ventral surface of abdomen with a round impression near apex. Legs rather long and thin, unarmed.

♀. Differs in not having the seventh joint inflated, metasternum not so excavated and ventral surface without preapical impression. Length, 1·35 mm.

Hab.—Victoria: Belgrave and Emerald (C. Oke), found associating with *Amblypone obscurus*; Bayswater (J. E. Dixon).

Types in author's collection.

Eupinolus socialis, n. sp.

♂. Reddish-castaneous. Clothed with short pale pubescence.

Head large, slightly wider than prothorax, much narrowed in front; with a large round impression between antennae and two small round interocular foveae. Antennae with joint 1 larger than 2, 3-4 smaller, 5 nearly as long as 2, 6-8 small, subequal, 9 as wide as 2, 10 a little larger, 11 largest, ovate-acuminate. Prothorax widest in front of middle, rounded on sides, rather suddenly constricted near base; a small round median fovea at base, with fine microscopic punctures. Elytra longer than wide, sutural striae distinct to apex, discal striae faintly indicated near base; punctures more distinct than on prothorax. Abdomen short, declivous; second ventral flattened, and a transverse impression on the fifth. Metasternum widely impressed. Intermediate trochanters compressed and obtusely produced in middle.

♀. Differs from the ♂ in having the ventral surface of the abdomen convex and the trochanters unarmed. Length, 1·25 mm.

Hab.—Victoria: Fern Tree Gully and Belgrave (C. Oke), found in nests of *Amblypone australis.*

Types in author's collection.

EUPINOLUS OBSCURUS, n. sp.

Similar to *E. parasitus*, but larger, darker and the antennae not the same. The seventh joint is much larger and is produced inwards on the apex; the eleventh joint is much larger than in the preceding species.

Hab.—Victoria: Evelyn (C. Oke) in a nest of *Amblypone obscurus.*

This may prove to be only a variety, or form, of *E. parasitus*, but even so it would be desirable to give it a varietal name. Of the numerous specimens I have obtained of *parasitus* none has shown any sign of bridging the differences between that species and *obscurus.*

Type (unique) in author's collection.

EUPINODA FRATERNA, n. sp.

♂. Reddish-castaneous; abdomen, except apex, darker. Clothed with short pale pubescence, scarcely visible on prothorax and elytra.

Head rather small, narrowed in front, with two small, round, interocular foveae. Antennae with joint 1 large, 2 smaller, 3-4 still smaller, equal, 5 lightly inflated, 6-8 same as 3, 9 as wide as 5, transverse, 10 larger, 11 pedunculate at base, then suddenly wider than 10, the large part ovate-acuminate. Prothorax widest at apical third, much narrowed to apex. Elytra longer than wide, sutural striae distinct to near apex; shoulders slightly raised; with a fine scattered punctation. Metasternum widely impressed, subcarinate around depressed part. Second ventral segment (first visible) large, flattened, with two small tubercles, close together, nearer base than apex, segments 3-5 shortened down centre, 6 large, widely foveate. Legs long; the posterior trochanters compressed and obtusely produced in middle; the femora lightly inflated in middle and the tibiae thickened towards apex. Length, 1·20 mm.

Hab.—Victoria: Belgrave (C. Oke) in nests of *Amblypone obscurus.*

The tubercles on the abdomen are small and lightly transverse, with the distance between slightly more than the length of each tubercle. The fifth joint is not so large as in most species of *Eupines* having that joint inflated, but is distinctly larger than adjacent ones. The club appears to be formed by the last two joints only, though the ninth is wider than the eighth. The tenth has the base very thin or stem-like, with apex suddenly clavate.

Type in author's collection.

EUPINES NIGELLA, n. sp.

♂. Black or almost so, appendages dark brownish. Clothed with very short, fine, adpressed pubescence.

Head small, narrowed in front of eyes, without impressions. Antennae with joints 1 and 2 stout, 3-8 moniliform, 9 slightly wider, transverse, 10 wider, transverse, 11 largest, ovate. Prothorax widest in front of middle, where sides are rounded. Elytra subparallel-sided, with sutural striae indistinct. Ventral surface of abdomen flattened, apical segment impressed. Metasternum widely impressed. Anterior femora strongly inflated; intermediate less noticeably so; posterior scarcely inflated. Anterior tibiae suddenly narrowed at apical fourth; intermediate with a short sharp spur at apex; posterior mucronate at apex.

♀. Differs in not having inflated femora, tibiae unarmed, abdomen not flattened and without impression, metasternum not so widely impressed and antennae a little thinner. Length, 0·90 mm.

Hab.—Victoria: Fern Tree Gully, Gembrook (C. Oke).

A small narrow black species, flatter and more parallel-sided than usual, with a distinct spur on middle tibiae. The pubescence is very fine and scarcely visible under a hand lens, but under a ½ inch compound lens is very conspicuous.

Eupinion, n. gen.

Body elongate, convex. Head transverse; eyes prominent submedian; antennae rather short; palpi as in *Eupines*; under surface without median carinae. Prothorax without impressions. Elytra with sutural and discal striae. Abdomen with narrow margin, declivous posteriorly. Anterior coxae conical, prominent, sub-contiguous; intermediate contiguous; posterior sub-globular, lightly separated. Size minute.

The beetle for which this genus is proposed has somewhat the facies of *Eupines*, but is without the median carina on under surface of head, which is quite a conspicuous character in *Eupines*; the discal striae on elytra add another distinction.

In the single species described the grooves on front of head and the produced apex of abdomen, with the pygidium on the ventral surface, are characters unknown in *Eupines*, but these may be merely specific. The latter character occurs in some species of *Tyramorphus*, while others have the apex normal.

Genotype, *E. crassipes*.

Eupinion crassipes, n. sp.

♂. Dark castaneous-brown, appendages almost flavous. Moderately clothed with short, fine, depressed, ashen pubescence; a few long hairs below eyes.

Head with two round interocular foveae, and two longitudinal impressions between antennae. Antennae rather short; joint 1 large, 2 slightly smaller, 3-8 small, 9 very little larger, 10 large, transverse, 11 largest, as long as four preceding combined. Prothorax widest about middle, evenly decreasing to apex, rather suddenly narrowed before base; finely and rather closely punctate. Elytra slightly longer than wide, sides rounded and increasing to beyond middle; punctures as on prothorax; sutural striae distinct to apex, discal stria represented by a deep notch, a fine stria near margin, visible to middle. Abdomen strongly declivous posteriorly, the apex somewhat produced and bent under, the pygidium on ventral surface, under surface lightly flattened, the apex of fourth segment deeply emarginate in middle and on each side of emargination a triangular projection. Metasternum rather deeply impressed and finely carinate on each side. All the femora inflated, the intermediate largest and with a small sharp tooth at base, the anterior carinate on the inner under edge. Intermediate tibiae inflated in middle, notched at base, spinose at apex.

♀. Similar but under surface of abdomen lightly convex, with the intermediate and posterior femora, and middle tibiae not inflated. The anterior femora are lightly inflated. Length, 0·80 mm.

Hab.—Victoria: Noble Park (C. Oke), in moss with numbers of a small black species of *Iridomyrmex*.

Type in author's collection.

MALLEECOLA, n. gen.

Head large, with prominent carinae; truncated in front; a cuneiform process at base of eyes. Under surface with a median carina from mentum to base. Eyes moderate, coarse facets, sub-median. Antennae eleven-jointed, club large, of three or more joints; fairly close together at their insertion. Mentum longer than wide. Maxillary palpi rather small; first joint scarcely visible, second long, thin at base, suddenly clavate near apex, third short, sub-globular, fourth slightly shorter than second, subfusiform, lightly truncate at apex, where there is a minute appendage. Prothorax with carinae on disc and flanges on the sides. Elytra with strong sutural and discal striae. Abdomen of 6 segments, lateral margin strong, first ventral hidden under the metasternum, second segment longer than the following ones. Prosternum very short. Mesosternum with a slightly raised intercoxal process. Metasternum large. Anterior coxae conical, prominent, approximate; intermediate not prominent, lightly separated; posterior somewhat triangular, distant. Trochanters short. Femora and tibiae compressed and angular; femora grooved for reception of tibiae, tibiae grooved for tarsi. Tarsi with minute basal joint, 2 and 3 subequal, a single robust claw.

It is with some doubts that I refer this genus to the Brachyglutini, but if that is not its right position it would require a new tribe, as it certainly cannot be referred to any other tribe as defined by M. Raffray.

Genotype, *M. myrmecophila*.

MALLEECOLA MYRMECOPHILA, n. sp.

♂. Reddish-castaneous; antennal joints 8-9 infuscated. Clothed with fine subsquamose pubescence, more noticeable on head and prothorax, which are subopaque and have fine reticulate punctures, than on elytra and abdomen, which are subnitid and have a very fine punctation.

Head longer than wide (as 6 : 5 or including ocular processes 6 : 8½), flat on vertex, the front of which is carinated and tri-lobed, the lateral margins carinated and quadri-lobed; from the central lobe of anterior margin a well-raised carina runs back about one-third towards base, then branches and diverges towards sides and then converges towards base (thus enclosing a square), a short carina to each eye; a fovea at base, carinated on its sides; posterior margin raised; in front of vertex concavely declivous with the anterior margin tri-lobed, central lobe narrow and slightly produced; under surface produced into a cuneiform process on each side cutting through the eyes. Antennae thick, reaching middle of prothorax; joint 1 thick, as long as next 3 combined, 2 same width, transverse, 3-7 narrower, transverse, equal, 8 wider, very thin, closely applied to 9, 9 wider, thin, 10 same width as 9 but longer, 11 largest, truncated. Prothorax (excluding flanges) longer than wide; tri-carinate, the lateral carinae becoming subobsolete at basal third; base bilobed; hind angles somewhat produced and rounded; an elongate median basal fovea; with wing-like flanges on the sides, having fairly acute points in front, widely rounded behind. Elytra with sutural striae foveate at base and distinct to apex, discal striae foveate and widely impressed at base, becoming obsolete near apex; shoulders raised, from apex of shoulder a fine carina extends to apical fourth of each elytron; lateral margins extended and carinate, hind margins sinuous, shortened at suture; epipleurae without impression. Metasternum widely and deeply impressed. Ventral surface of abdomen lightly flattened, with a small round node or swelling at apex of second segment. Anterior trochanters compressed and produced into an obtuse tooth. Femora wide and thin, tibiae with inner margin straight, outer

rounded from base to beyond middle, then obliquely cut away to apex, which is truncated.

♀. Similar to the ♂, but the antennal club is not so large and the tenth and eleventh are more separated. The metasternum is not so widely nor deeply impressed, though still noticeably so. The abdomen is slightly more convex beneath and is without node on second segment. Length, 1·70-1·90 mm.

Hab.—Victoria: Gypsum and Lake Hattah (C. Oke), in nests of *Iridomyrmex rufoniger*.

This is, I consider, the most remarkable looking Pselaphid described from Australia, and it is exceedingly difficult to give a satisfactory description of it in a few words. The carinae of the head are very conspicuous, forming a square placed so that a corner points towards each eye, the four points being connected with the margins by short carinae. The fovea of the pronotum looks as though it had been impressed into the median carina, splitting it and having a thin, or narrow, piece of the carina on either side. The legs are quite different from any Pselaphid known to me, but are very much like some species of the Histerid genus *Chlamydopsis*. The club is four-jointed with the 8th, 9th and 10th so closely applied to one another that under a hand lens they appear as one joint.

Types in author's collection.

Pselaphini.

PSELAPHUS ALLUVIUS, n. sp.

♀. Dark reddish-castaneous; elytra paler, palpi and tarsi pale testaceous. Nitid. Thickly clothed with long dark hair-like setae, tips of tibiae with yellowish pubescence; apex of mesosternum and base of abdomen, on under surface, with dense pearly squamose pubescence.

Head with median sulcus narrow in front, widened and interrupted behind eyes, feebly indicated on vertex to near base; with two interocular tubercles, antennal tubercles very pronounced; with large rough uneven punctures. Antennae long, joint 1 nearly as long as next three combined, 2 wider than 3, 3-8 about same width, 9-10 each widened from base to apex, 10 wider than 9, 11 large, ovate-acuminate. Palpi nearly as long as antennae, fourth joint with short straight peduncle, club large, longer than peduncle, strongly rounded on outside, with a wide sulcus on apical third of club. Prothorax longer than wide, widest at apical third, much narrowed to apex; base with a straight impression, without interruptions; punctures as on head. Elytra with four basal foveae; sutural and discal striae distinct to apex, with a short stria between them on each elytron; without punctures. Abdomen with first visible segment longer than the others combined; very strongly margined; under surface convex. All the femora rather strongly inflated. Metasternum sulcate anteriorly, then abruptly declivous and largely excavated. Length, 2·50 mm.

Hab.—Victoria: Bendigo (C. Oke), clinging to under surface of a stone on the old alluvial diggings.

A large robust species at once distinguished from previously described Australian species by the large punctures on head and thorax.

Type in author's collection.

PSELAPHUS ELECTILIS, n. sp.

♂. Bright reddish-castaneous. Nitid. Clothed with moderately long dark setae, apex of elytra distinctly fringed; apex of pro- and mesothorax and base of abdomen, on both surfaces, with dense pearly squamose pubescence.

Head with median channel wide and deep, continuous from apex to base, but interrupted between eyes by two minute black tubercles; between these and eyes are two large rounded tubercles; the antennary tubercles strongly raised. Antennae long, all the joints longer than wide, 9-10 a little stouter than preceding joints, their combined length longer than 11, which is ovate. Palpi as long as antennae; fourth joint curved, its club rather small, barely one-third of the length of joint, sulcate with a short seta at apex. Prothorax longer than wide, with the sides gently rounded; base with a narrow transverse groove, in front of which is a vague impression; sides with a rounded fovea connected with a triangular impression, these almost isolated. Elytra with four small round basal foveae; shoulders obliquely ridged; with sutural striae very distinct to apex, discal striae curved, geminate to near apical declivity, where inner one ends, outer almost reaching margin. Abdomen with second segment as long as the following segments combined; on its under surface with an elongate-oval depression, apex sulcate. Metasternum widely and deeply impressed from base to apex, excavate posteriorly.

♀. Differs from the ♂ by the metasternum not being sulcate at apex and only lightly excavate posteriorly and second segment without depression. Length, 2·25 mm.

Hab.—Victoria: Pakenham and Belgrave (C. Oke), in moss.

A very fine species, in appearance nearer to *pulchellus* than any other known to me, but the clothing is shorter and not so dark and the elytral striae are geminate. Nearer to the description of *pilosus* than any other Australian species, but the sulcus on head continued to base and not narrow, the shoulders are also marked. The inflated "button" on under surface of head is unusually large.

Types in author's collection.

PSELAPHUS SULCIVENTRIS, n. sp.

♂. Pale castaneous; palpi, legs and elytra somewhat flavous. Sparingly clothed with pale, hooked or bent, pubescence; apex of elytra fringed; apex of mesosternum and base of abdomen with dense pearly squamose pubescence.

Head much attenuate in front, median channel rather narrow, abruptly ending between eyes; with fairly conspicuous, but obtuse, interocular tubercles; behind each tubercle, near eye, are five large punctures, elsewhere smooth. Antennae of moderate length, all the joints longer than wide, eleventh ovate, the last three forming a light club. Palpi with the fourth joint elongate, arcuate, with club about one-third total length. Prothorax longer than wide, base with an uninterrupted impression, sides with an oblique impression from end of transverse impression to base. Elytra with four basal impressions, sutural striae distinct to apex, discal striae finely geminate to apical declivity. Abdomen with first segment longer than the following segments combined; ventral surface with a fairly narrow sulcate impression from base to apex. Metasternum narrowly flattened on apical three-fourths, then excavate posteriorly. Posterior tibiae dilated to near apex, then rounded off. Length, 1·50 mm.

Hab.—Victoria: Gypsum (C. Oke), near nest of *Euponera lutea.*

A small pale species, in some respects close to *geminatus*, but head and base of pronotum not reticulate. It is also near to *tuberculifrons*, but antennae are different and dorsal striae geminate. From some directions there appears to be a minute tubercle on the vertex of the head, but from the sides this is not visible.

Types in author's collection.

PSELAPHUS SQUAMULOSUS, n. sp.

♂. Pale castaneous; legs and palpi paler. Clothed with short pubescence, having the appearance of small scales in parts, rather sparse on elytra where it is arranged in four rows; front of prosternum, sides of mesosternum and base of abdomen with pearly-white squamose pubescence.

Head with median channel rather wide and deep, ending a little behind eyes, but interrupted between eyes; in front of eyes, two basal joints of antennae and extreme base finely reticulate. Palpi long; fourth joint arcuate, with its club about one-third of total length, its apex lightly produced on inner side, on the outer side obliquely cut away and sulcate, the sulcus with fine pubescence. Antennae with joint 1 large, 2 much smaller, 3-8 cylindrical, of same width, 9-10 a little stouter, 11 a little wider than 10, as long as two preceding combined. Prothorax subhexagonal, widest behind middle, the base with a wide transverse impression, which is finely reticulate and without impressions; the sides with an elongate impression, narrow at base and ending in a round foveate expansion near middle, carinate at its outer edge and around the expansion. Elytra with sides rounded from base to apex, base with four foveae; sutural striae distinct to apex, discal very distinct to apical declivity, strongly curved inwards. Abdomen with first segment large; ventral surface with an elongate impression on the first (visible) segment. Metasternum rather widely excavated posteriorly. Legs long.

♀. Differs in having the abdomen convex underneath and without impression, the metasternum not so excavated and the antennae a little thinner with its apical joint smaller. Length, 1·80 mm.

Hab.—Victoria: Fern Tree Gully, Emerald (C. Oke).

The clothing is of a reddish-yellow and on the abdomen is adpressed and appears to be in the form of small scales.

Types in author's collection.

Ctenistini.

NARCODES SQUAMOSUS, n. sp.

♂. Dark piceous, in parts almost black; antennae (club excepted) and legs diluted with red; palpi pale castaneous. Upper surface covered with pale yellowish scales, under surface and appendages clothed with pale stiff pubescence. Punctures large and sparse, much obscured by the clothing.

Head with antennal tubercles distinctly raised and separated on the sides from the head by a notch; behind antennae strongly impressed, and with two large round interocular foveae; hind angles rather strongly produced and a point on each eye. Antennae fairly long, joint 1 stout and long, 2 shorter but stouter than 3, 3-8 diminishing in length, 9-10 large, increasing, 11 truncate-ovate. Prothorax with anterior angles strongly produced downwards into a sharp point, just behind which is a smaller projection; a large medio-basal impression and a larger impression on the sides. Elytra transverse, sutural and discal striae deeply impressed and distinct to near apex, shoulders obliquely raised. Abdomen much longer than elytra, strongly margined; under surface sulcate from base to apex, the latter foveately impressed. Metasternum widely and deeply excavate; sides of excavation carinate and ending in a blunt tubercle overhanging the hind coxae. Legs long; anterior trochanters produced into a short truncated process; all the femora inflated, the anterior with a very small tooth near base; all the tibiae strongly curved and obtusely spurred at apex; tarsi short.

♀. Similar, but club small with the 11th joint almost globular; the metasternum not so excavate, and under surface of abdomen convex. Length, 2·10 mm.

Hab.—Victoria: Warburton (C. Oke).

The clothing of the upper surface consists entirely of fairly large scales. These are of a pale yellowish colour, but owing to the inequalities of the surface the light strikes them at different angles and gives the insect a mottled appearance. The prothorax appears to have a feeble ridge down the disc from some directions, while from others there appears to be a V-like impression. On each eye there appears to be a small conical projection composed of a few scales.

The shape of the head, prothorax and sternum will distinguish this species from the previously described ones.

Types in author's collection.

Tyrini.

TYROMORPHUS TERMITOPHILUS, n. sp.

♂. Reddish-castaneous; tibiae and tarsi darker, the extreme base of head, pronotum and antennal joints infuscated. Clothed with rather long reddish pubescence.

Head nearly as wide as prothorax, much narrowed in front; with an impressed line from base to front, and two foveae close together in centre of vertex, connected together across central line; large rough punctures. Antennae reaching middle coxae, joint 1 large, 2-10 oblong, of equal width, 11 a little wider, nearly as long as three preceding combined. Palpi with third joint sub-triangular, fourth very large. Prothorax quadrate, convex, rounded on the sides, a small medio-basal fovea, punctures not quite so conspicuous as on head. Elytra transverse, narrowed to base; sutural striae foveate near base, discal striae foveate and widely impressed at base, becoming obsolete near middle; shoulders raised; punctures as on head. Abdomen with punctures as on pronotum; under surface deeply impressed from base to near apex. Metasternum widely impressed. Legs long and unarmed.

♀. Differs from the ♂ in having the under surface of abdomen non-sulcate and the metasternum with a smaller impression. Length 2·75 mm.

Hab.—Victoria: Violet Town (C. Oke), in nest of *Coptotermes acinaciformis* Frogg.

Types in author's collection.

TYROMORPHUS QUADRIDENTATIS Lea.

Several females of this species are before me, one of which Mr. Lea has kindly identified for me, and these show that the species is variable in its colour. The darkest specimen has its head, pronotum and abdomen almost black, from some directions it is quite black, from others there are reddish lights, the under surface is infuscated, the elytra ruby-red with the suture and apex blackish, the two basal and apical joints of antennae reddish, joints 3-7 infuscated, 9-10 black. The palest is bright reddish-castaneous, suture, abdomen and under surface darker, 11th joint pale, palpi flavous. The paler specimens may be immature or perhaps some individuals do not attain the darker colours. This variation in the colour leaves the presence or absence of the medio-basal fovea on the pronotum as the only difference between *quadridentatis* and *spinosus*. It may seem strange, but the fovea, though of exactly the same size, does not show up so distinctly on the darker examples. I doubt whether *quadridentatis* is distinct from *spinosus*. As the male has not been described I give its sexual characters.

♂. Metasternum widely and deeply impressed. Under surface of abdomen with a wide deep excavation from base to apex, the apex itself produced and curved under. Legs robust; anterior trochanters armed near base, intermediate produced into a round tooth at apex; the anterior femora strongly inflated, constricted near apex, a sharp tooth at base, intermediate very strongly inflated, upper edge widely rounded, lower lightly rounded, with a golden fascicle in centre, a small round protuberance at apical third crowned with a long thin testaceous fascicle; posterior lightly inflated and constricted near apex; anterior tibiae strongly curved, intermediate tibiae rather thick with a compressed spur-like fascicle a little nearer apex than base, from spur to near apex obliquely narrowed, the apex produced inwardly into a cuneiform spur, with numerous bristles near apex, hind tibiae widened to apex, near where it is notched and with a compressed fascicle of hairs.

Victorian localities: Evelyn, Emerald and Warburton (C. Oke), first record from the mainland.

Allotype ♂ in author's collection.

Tyromorphus speciosus King.

Numerous specimens of this species have been taken by Mr. J. E. Dixon and myself in the Dandenong Ranges, most of them under stones and logs where there have been nests of *Amblypone australis*; whether there has been any actual association between the ants and beetles has not been observed, but it is rather doubtful, because several have been taken where there were no ants of any kind. Mr. Lea has given (These Proceedings, 1910) a full description of the ♂ and a very fine figure of same, but the ♀ has not been described.

♀. Differs from the ♂ in having head slightly smaller, with the impressions less distinct; the dorsal surface of abdomen without the raised process and non-fasciculate, and the under surface non-sulcate; the metasternum unarmed. Anterior trochanters acutely dentate. Anterior and intermediate femora armed, posterior not armed.

In both sexes, figured but not mentioned by Lea, there is an acute tooth at base of anterior femora, and from this there is a short carina ending in a small oblique tubercle.

Hab.—N.S. Wales: Otford (A. M. Lea); Victoria: Fern Tree Gully (J. E. Dixon and C. Oke), Upwey (Dixon), Belgrave and Emerald (Oke).

Allotype ♀ in author's collection.

Tyromorphus tibialis Wilson.

There are fourteen specimens of this species before me and these show some slight variation in the colour of the antennae. One pair, ♂, ♀, taken together, have joints 1-8 pale reddish-yellow, 9-10 black, or almost so, 11 dull ruby-red, but most specimens have four or five joints blackish, while one specimen has all the joints 2-11 black, or almost black. In all the specimens before me the suture, base of elytra, the shoulders and apical angle of elytra are either infuscated or black. The ♀ has not been described.

♀. Similar to the ♂ and has the anterior trochanters and femora armed as in that sex, but differs in the intermediate trochanters and tibiae not being armed; the metasternum not so deeply impressed and the ventral surface of abdomen convex.

Hab.—Victoria: Warburton (F. E. Wilson and C. Oke), Evelyn in tussocks, Pakenham in moss, Fern Tree Gully in moss and in nest of *Amblypone australis* (Oke), Drysdale in nest of *Chalcoponera metallica* (Rev. P. C. Nye).

Allotype ♀ in author's collection.

Palimbolus rugosus, n. sp.

♂. Castaneous; disc of elytra and appendages reddish. Thickly clothed with long black hooked setae.

Head rather small, narrowed in front, with the antennary tubercles strongly raised; with large, rugose, confluent punctures. Antennae with basal joint longer than next four joints combined, joint 2 much narrower than 1, 3 smaller, 5 a little longer than 4, 6 quadrate, 7-8 subequal, transverse, 9-10 larger, increasing, transverse, 11 ovate truncate, lightly bent. Prothorax subhexagonal, widest a little in advance of middle; with a large medio-basal fovea and the sides obliquely impressed; punctures as on head. Elytra transverse, sutural striae distinct, discal widely impressed at base, becoming obsolete near middle, shoulders raised and oblique; with a fine scattered punctation. Abdomen with punctures as on elytra; under surface flattened, with a triangular impression on apical segment. Mesosternum sulcate with sides of sulcus carinated. Metasternum convex, lightly impressed down centre, a little excavate posteriorly. Intermediate trochanters with a very small sharp tooth, posterior with a short blunt tooth. All the femora lightly inflated, the intermediate more noticeably so than the others. Inner claw of anterior tarsi trifid. Tibiae straight and simple.

♀. Similar to the ♂, but differs in having trochanters not armed, antennae a little thinner, abdomen convex and inner claw of anterior tarsi simple. Length, 3-3·20 mm.

Hab.—Victoria: Carrum and Frankston (C. Oke).

A very fine species allied to *P. dimidiatus* Raff which has been described as having the basal joint of antennae long and the head and prothorax with rugose confluent punctures, but the ♂ of that species has "a strong impression from middle coxae to apex of abdomen" and the posterior tibiae armed.

Type in author's collection.

Palimbolus postcoxalis, n. sp.

♂. Dark reddish-castaneous; appendages somewhat lighter, head and prothorax almost black. Clothed with rather dense dark pubescence.

Head with two round interocular foveae and the front deeply impressed; with a few scattered punctures, becoming closer on antennary ridges. Antennae stout; joint 1 long, longer than 2-3 combined, 2 small, 3, 4, 5 increasing in width, 3-4 subequal in length, 5 longer, 6-7 shorter than 5, 8 short, transverse, 9-10 increasing, transverse, 11 large, longer than 9-10 combined, an oblique impression on under surface at base. Prothorax slightly longer than wide, widest in front of middle; with a deep medio-basal impression, the sides with a longitudinal impression, foveate before middle; with a few fine scattered punctures. Elytra slightly wider at apex than length, narrowed to base, with four basal foveae; punctures rather coarse and fairly close. Abdomen strongly margined; under surface lightly flattened, excavate near apex. Metasternum widely excavate posteriorly. Intermediate trochanters with a long curved process, truncate at apex. Posterior coxae produced into a sharp tooth over the trochanters, which are armed with a strong tooth. All the femora lightly inflated, the posterior notched

and with a blunt tooth near base. Hind tibiae with a short, obliquely truncated, spur at apical fourth and a minute spur at apex. Front inner claws trifid.

♀. Differs from the male in having the under surface of abdomen convex, legs unarmed, 11th joint without impression, and front inner claws simple. Length, 3 mm.

Hab.—Victoria: Warburton (C. Oke).

In appearance much like *victoriae* King, but the armature of the hind coxae and femora, and the absence of tubercles from abdomen will distinguish it from that species. The fifth joint of the antennae when viewed from above is wider than its neighbours, but is scarcely so, if at all, when seen from the side. On the under side the 10th is produced to fit into the impression on the 11th.

Type in author's collection.

Neopalimbolus, n. gen.

Body oblong. Head attenuate in front. Eyes median. Antennae thick, with three-jointed club, the bases distant and their tubercles prominent. Palpi long: first joint moderate, second long, very thin at base, suddenly clavate at apical third; third joint about half the length of second, pedunculate at base, clavate from basal third; fourth subfusiform with a short peduncle. Prothorax cordiform, with impressions. Elytra short, with striae. Abdomen, long, with wide margin. Intermediate coxae contiguous with their trochanters, long. Posterior coxae distant. Tarsi with first joint small, second long and continued as two long filaments below the plane of the third, which is the longest joint and carries two well-developed claws, the inner claw of the anterior tarsi trifid in ♂, simple in ♀.

This genus resembles *Palimbolus* in facies, but differs from that genus by the maxillary palpi and the tarsi. The latter are quite unlike those of any species known to me in nature, but are somewhat like the tarsus of *Caccoplectus celatus* Sharp, figured by Raffray (*Genera Insectorum*, Plate 9, Fig. 10).

Genotype, *N. goudiei.*

Neopalimbolus goudiei, n. sp.

♂. Dark reddish-castaneous; elytra paler, palpi flavous. Clothed with long pubescence, appearing pale in some lights, almost black in others.

Head slightly longer than wide, rather deeply impressed between antennal tubercles; with three interocular foveae, one near each eye and one further back on vertex; a few coarse punctures on antennal tubercles, elsewhere smooth. Antennae reaching middle coxae; joint 1 stout, cylindrical, longer than next two combined, 2-6 slightly decreasing, 7 smaller, 8 smallest, 9-10 transverse, 10 larger than 9, 11 ovate, not quite length of two preceding combined. Prothorax about as wide as long, widest before middle, somewhat angular and flattened on sides; with a large oval medio-basal impression and three impressions on each side, one near base, one premedian and one at apex; almost impunctate. Elytra transverse, angles rounded away and dilated to apex; sutural stria distinct, with an impression near base, discal impression oblique, with a basal fovea; with a moderate scattered punctation. Abdomen slightly wider than elytra; punctures much as on elytra; under surface lightly flattened. Metasternum depressed. Legs unarmed.

♀. Similar to male, but abdomen convex and sternum not so impressed. Length, 2·25 mm.

Hab.—Victoria: Sea Lake (J. C. Goudie), Gypsum (C. Oke, November).

I have much pleasure in naming this interesting species after Mr. J. C. Goudie, who was the first to collect it.

♀ GERALLUS (TYRUS) HOWITTI King (= ♀ *nec* ♂ *Tyromorphus howittii* King (Lea) = ♂ *Gerallus decipiens* Lea = ♂ *Schaufussia mona* Wilson).

There can be no mistake about the above synonymy as I have several specimens of both sexes before me and have taken a pair *in cop.* Mr. Lea, in redescribing King's type, mistook that specimen for the ♂ on account of the armature of the trochanters, but they, and the femora, are the same in both sexes. By the kind permission of Mr. Kershaw, I have examined King's type in the Howitt collection, now in the National Museum, and find it is a ♀, the under surface of abdomen being gently convex.

The great difference in the head of the ♂ from the ♀, while not previously noted in *Gerallus*, is found in the allied genus *Rytus* and Mr. Lea has drawn attention, in both of his descriptions, to the fact that this species greatly resembles *Rytus subulatus.*

Hab.—Victoria (Howitt, and Macleay Museum), Warrandyte (Wilson), Eltham, Ringwood and Bayswater (Oke).

CLAVERGERINAE.

CLAVERGEROPSIS AUSTRALIAE Lea.

Only the ♀ of this species has been described by Lea; having taken the ♂, I complete the description by adding its sexual characters.

♂. Mesosternum with diverging carinae on sides, the centre with a sharp carina. Metasternum raised, subcarinate, abruptly declivous behind. Abdomen lightly flattened and with vague impressions. Anterior femora flattened beneath, intermediate lightly flattened beneath, arcuate on outer edge, a strong spur near base on inside. Intermediate tibiae with a small tooth on inside near apex.

Hab.—N. S. Wales (after Lea); Victoria: Pakenham (C. Oke).

Allotype ♂ in author's collection.

ARTICERUS LEAI, n. sp.

♂. Reddish-castaneous. Moderately clothed with short pale depressed pubescence, a few short setae at apex of elytra, between middle coxae and on base of metasternum with golden pubescence.

Head longer than wide, lightly dilated behind eyes; closely punctate. Antennae longer than head, base narrow, then strongly dilated to beyond middle, where it is fairly wide and flattened, and then feebly diminishing to apex, apex almost circular in cross-section; with a shallow impression in middle. Prothorax feebly transverse, widest at apical third, suddenly narrowed to apex, lightly narrowed to base; with a large round impression near base; punctures as on head. Abdomen with a deep transverse depression not encroaching on middle of convex portion, but continued on each side as an oblique impression, with a small fascicle on each side; under surface obliquely strigose at base; constricted and flattened along middle; apex with a small transverse process, crowned with a golden fascicle. Prosternum unarmed; with large punctures, especially on sides. Metasternum rather strongly excavated posteriorly, with two small tubercles placed transversely near apex of excavation. The femora inflated; the middle, which has an acute (somewhat hooked) tooth at basal third, more strongly than the others. Middle tibiae strongly inflated and produced into an acute tooth at apex on lower

surface; on upper surface strongly notched and cut away at apical third, leaving an acute tooth. Length, 1½ mm.

♀. Differs in having the metasternum declivous, but not excavate, and unarmed; the abdomen convex and unarmed; legs less inflated and unarmed.

Hab.—Victoria: Lake Hattah (C. Oke), in nests of *Iridomyrmex.*

A small, narrow, almost parallel-sided species with antennae much as in *mastersi* Lea, but abdomen very different. In Lea's table of the genus, it would be associated with *aurifluus* Schauf. by "metasternum transversely armed", but in the present species the tubercles are very small and continue the plane of the sternum, while in *aurifluus* they are at right angles. The tubercles are so small that they might easily escape notice, and taking the metasternum as unarmed, it would be associated with *irregularis* Lea, from which species it differs, *inter alia*, by the antennae and middle tibiae.

Type in author's collection.

Articerus fimbriatus, n. sp.

♂. Reddish-castaneous. Conspicuously clothed subsquamose pubescence, except in abdominal excavation, which is highly polished; intermingled with the pubescence are numerous setae, which form a rather conspicuous fringe around pronotum and at apex of elytra; on the abdomen are some longer hairs, particularly in excavation and a row across pygidium.

Head long, almost cylindrical, very little wider behind eyes than before, bluntly pointed; with fine sparse punctures. Antennae moderately long, thin at base, then suddenly widened and flattened, circular at apex, lightly concave on inside edge. Prothorax transverse, angles widely rounded; with a large elongate foveate impression in front of base; punctures closer than on head. Elytra wider than prothorax at base, dilated to apex; subsutural striae fairly distinct; punctures much as on thorax. Abdomen with a deep transverse excavation, feebly encroaching on middle of convex portion; with conspicuous fascicles on the sides; under surface flattened and constricted across middle. Metasternum feebly raised in centre, scarcely tuberculate, thence sloping away, but not excavated. Middle trochanters armed with an acute tooth at apex. The femora lightly inflated. Anterior tibiae with a truncated process at apical third, middle tibiae with a curved sharp tooth at apical fourth. Length, 1·60 mm.

Hab.—N.S. Wales: Glen Innes (W. du Boulay), in nest of *Iridomyrmex.*

The most conspicuously clothed species known to me, the long hair-like setae on the abdomen being very noticeable.

In general appearance somewhat like *aurifluus* Schauf., but the antennae are longer and narrower, and there are differences in the clothing, sternum and legs.

Mr. du Boulay took several specimens which were running about freely and mating in the nests, and he has kindly given me two males.

Types in author's collection.

Articerus angusticollis Westwood.

♂. Obscure castaneous. Well clothed with short pale pubescence, becoming thicker and longer on elytra towards apex; the lateral ridges of abdomen with a distinct golden fascicle and sides with a few longer hairs. Antennae, head, both surfaces, prothorax, elytra and mesosternum with distinct reticulate punctures; middle of metasternum and under surface of abdomen indistinctly punctured.

Head elongate, somewhat triangular in front, feebly widened behind eyes. A few long setae protruding from mouth. Antennae thin at base, then compressed and rather suddenly widened, straight on inside, lightly rounded on outside, truncate at apex, the apex itself oval. Prothorax subquadrate with an elongate impression on disc. Elytra quadrate, suture raised, sutural stria distinct. Abdomen with a transverse excavation not encroaching on middle of convex portion; under surface shortened down centre and flattened. Metasternum convex, declivous posteriorly. Anterior trochanters dentate. All the femora inflated, the intermediate more strongly than the others and with a rounded tooth at base covered with a golden fascicle. All the tibiae curved inwardly, rounded on outside; the anterior widened to apex, notched on inside and feebly spurred; intermediate widened to near apex, which is strongly spurred; posterior widened to near apex and more strongly compressed than the others.

♀. With under surface of abdomen convex and the legs unarmed.

Westwood's type was undoubtedly a ♀ of this species; he described the thorax as oblong, but this is hardly correct, though numerous specimens before me are so in appearance, but not by measurement. The elongate impression on the prothorax causes that segment to appear longer and narrower than it really is. The ♂ antennae are more rounded on the outer edge than the female, which are not so wide as Westwood's figure makes them appear to be.

Hab.—Victoria: Melbourne (after Westwood), Caulfield, Preston and Bendigo (C. Oke), in nests of a small black *Iridomyrmex.*

Buprestidae.

Stigmodera montigena, n. sp.

Subcylindric; violet-blue, antennae, scutellum and suture greenish-blue, elytra with the following markings yellow: two round postbasal and subhumeral maculae, an irregular premedial and an arcuate postmedial fascia, fasciae not reaching suture.

Head channelled, sparsely punctate in front, closely behind. Prothorax with sides strongly rounded, widest behind middle, apex truncate, base bisinuate, anterior angles obtuse, posterior acutely produced; disc finely and closely punctate; medial line indicated throughout, medio-basal fovea distinct. Scutellum lightly concave, with a few punctures. Elytra as wide as prothorax at base, sides nearly straight, apices with an oblique excision, finely bispinose; striate-punctate, intervals flat (except near apex), finely punctate and transversely wrinkled. Under surface finely punctate and almost glabrous. Dimensions, 10·5 × 3·5 mm.

Hab.—Victoria: Warburton Ranges (C. Oke).

Of the size and shape of *S. wilsoni*, but the punctation of the pronotum is finer and closer, also the sculpture of the elytra is different and this character will separate it from other allied species.

Type (unique) in author's collection.

Stigmodera fossoria Carter.

Several specimens of this species have been taken at Belgrave and Fern Tree Gully by Dr. F. M. Burnet and myself, and these show the markings, as described by Mr. Carter, to be constant, except that the extreme base of elytra is metallic. The green parts have a tendency to become blue or purple and in parts (particularly under surface) to give off brilliant metallic reflections.

Ptinidae.

Diplocotes minuta, n. sp.

Reddish-castaneous; head and sides of prothorax infuscated. Clothed with microscopic pale pubescence.

Head behind antennae strongly transverse, indistinctly bisinuate, sides hollowed out; finely reticulated. Antennae fairly long, joint 1 large, bent, 2 much smaller, thin at base, wider at apex, 3 oval, 4-9 moniliform, 10 largest, 11 much smaller, rounded at apex. Prothorax longer than wide, widest at apical third, where sides are strongly rounded; a transverse arcuate impression at basal third, somewhat dilated, but scarcely foveate, in middle; sides with an obtuse tubercle directed cephalad; longitudinally strigose. Elytra ovate, truncate at base; with large seriate punctures. Legs fairly long, femora lightly inflated, tibiae thin at base, feebly dilated to near apex. Length, 1·10 mm.

Hab.—Victoria: Bendigo, in nest of *Chalcoponera.*

The smallest species of the subfamily as yet described from Australia. In appearance it is very like *howittanus*, but much smaller and the transverse impression on pronotum is arcuately dilated in middle, but not deeply foveate as in *foveicollis.*

The unique specimen was taken under a large stone which covered an unusually large colony of the *Chalcoponera.* The beetle was first seen amongst a number of the ants with whom it was apparently on the best of terms.

Type in author's collection.

Diplocotes howittanus Westw.

A specimen from the Grampians, Victoria (C. Oke), shows a variety of this species in being larger and the antennae thicker than usual. It was taken under bark in company with some ants, but unfortunately no specimens of the latter were kept for determination.

Polyplocotes apicalis, n. sp.

Pale reddish-castaneous; antennae with intermediate joints darker. Rather thickly clothed with long yellowish pubescence, disc of meso- and metathorax and base of abdomen with squamose pubescence.

Head with declivous front carinate on either side and with a few large punctures; behind antennae transverse, bisinuate; punctures as on front. Antennae with joint 1 long and stout, 2 much narrower, 3 longer than 2, 4-7 transverse, 8 larger, 9 largest, 8-9 somewhat compressed laterally. Prothorax longer than wide, anterior angles widely rounded; near base with a wide transverse impression which is expanded in centre; with setiferous papulae and confluent punctures. Elytra ovate, truncate at base, with moderate-sized seriate punctures. Metasternum lightly impressed. Basal segments of abdomen apparently fused together and with a few scattered punctures. Legs rather long. Length, 1¾-2 mm.

Hab.—Victoria: Hattah, in nests of a small black species of *Iridomyrmex* (C. Oke).

A very distinct species, having the ninth, or apical, joint larger than the subapical, a character which will separate it from all previously described species of the subfamily. The papulae on the thorax are small but distinct, and mostly blackish, and each one bears a fairly long yellowish seta.

Type in author's collection.

Polyplocotes similis, n. sp.

Light castaneous; head and antennal joints 1-7 darker. Clothed with moderately long yellowish pubescence.

Head behind antennae strongly transverse and strongly bisinuate; eyes projecting; rugose-punctate. Antennae long, joints 1-7 rugosely punctate, joint 1 long, 2 thin at base, wider at apex, 3 a little thinner, 3-7 decreasing in length, increasing in width, 7 transverse, 8 very large, nearly as long as three preceding combined, 9 less than half length of 8, narrowed to and rounded at apex. Prothorax longer than wide, with a wide transverse impression near base; longitudinally strigose. Elytra oval, lightly truncate at base, with large close seriate punctures. Legs fairly long. Length, $1\frac{3}{4}$ mm.

Hab.—Victoria: Inglewood, in nest of *Crematogaster laeviceps* (C. Oke).

This species closely resembles *Diplocotes howittanus* Westw. and *Decemplocotes strigicollis* Lea in general appearance, but the former has eleven-jointed antennae and the latter ten-jointed, while the present species has only nine. My unique specimen was taken under a small piece of wood, where the ants had their nest, in the dry Mallee scrubs.

Type in author's collection.

Polyplocotes carinaticeps Lea.

This species has only been recorded from Western Australia, but in November, 1924, I took two specimens from a nest of *Crematogaster laeviceps* at Hattah, N.W. Victoria.

Bitrephes, n. gen.

Body short, oval. Head deflexed. Antennae two-jointed. Prothorax with a large impression. Elytra seriate-punctate. Sternum short. Anterior coxae lightly separated, intermediate well separated, posterior distant. Femora grooved for reception of tibiae. Tibiae sulcate.

This new genus makes an interesting addition to a remarkable group of beetles—the myrmecophilous Ptinidae. The antennae are nearer to *Ectrephes formicarum* than to any other described species, but are only two-jointed, not three, and the apical joint is larger. The prothorax is almost exactly as in *E. kingi*, but that species has very different antennae.

The front of the head seems to be raised into a conspicuous ridge, but this is due to the hollowing of the sides. The margin of the clypeus is semicircular, with the labrum long and protruding over the base of mandibles.

Genotype, *B. cuneiformis*.

Bitrephes cuneiformis, n. sp.

Reddish-castaneous; parts of head, basal joint of antennae and sides of prothorax infuscated. Clothed with minute pale pubescence and with thick golden pubescence between all the coxae and a round patch on abdomen.

Head behind antennae bisinuate and strongly transverse, rugosely punctate; the sides in front of antennae obliquely hollowed, where it is strigose, elsewhere with a few granules. Antennae with first joint large, rugosely punctured, second larger, flattened, subcuneiform, rounded off on outside edge, with microscopic reticulate punctures. Prothorax transverse, on both sides, in front of middle, produced into a sharp cuneiform projection, behind which is an elongate impres-

sion; here the sides are compressed into a thin angular projecting plate; the base with a transverse impression; a large round foveate impression before base, from which striolae radiate. Elytra equal in length and width, base bisinuate; the striae lightly impressed and having large, round, setigerous punctures. Under surface of abdomen with large shallow punctures becoming more numerous towards apex. Femora lightly inflated, tibiae compressed, bent near base, the two posterior pairs feebly serrated on upper edge. Length, 1·20-1·50 mm.

Hab.—Victoria: Lake Hattah, in nests of *Iridomyrmex rufoniger* (C. Oke).

Several specimens of this very interesting little inquiline were taken, some under cover in the nest itself, others in the beaten down "footpaths" or tracks between the nests. The beetles appear to be on very good terms with the ants and if a beetle is turned over on its back, several ants will come to its assistance and help it to turn over again. Beyond this I was not able to observe any intimacy between host and guest, but this was very well demonstrated by turning over one beetle several times with a piece of grass.

Cerambycidae.

Atesta dixoni, n. sp.

♂. Dark piceous-brown, in parts diluted with red; antennae and legs dark reddish-brown; a sinuate premedial fascia and apex pale flavous. Subnitid. Thickly clothed with long greyish setae, joints 4-11 in addition with very short pale adpressed pubescence.

Head elongate, deeply channelled, antennal tubercles moderately prominent; with coarse rough punctures. Antennae with three joints beyond apex of elytra; second joint small, third very feebly armed, longer than first or fourth. Prothorax with sides trisinuate, medial swelling fairly acute; a transverse impression near apex, an impression near base; an elongate smooth node in centre and four smaller ones arranged around it; punctures large and rough, not sharply defined. Elytra elongate, parallel-sided to near apex, then rounded off, apices simple; shoulders obliquely raised; with large round seriate punctures becoming finer behind. Under surface with moderate-sized scattered punctures.

♀. Antennae not quite reaching apex of elytra. Length, 11-14 mm.

Hab.—Victoria: Lake Hattah (J. E. Dixon and C. Oke), bred from Black Box sticks.

In facies it is nearer to *bifasciata* than to any other described species, but differs in having much finer antennae, with the third joint almost imperceptibly armed, instead of strongly so, and apex simple instead of obliquely cut away. *A. angasi* has the apex oblique with a minute spine, and *tatei* has the apex emarginate and armed.

I have much pleasure in naming this after my friend, Mr. J. E. Dixon, who has bred it out on several occasions from sticks brought from Lake Hattah.

Type in author's collection, paratypes in coll. Dixon.

Atesta besti, n. sp.

♀. Black; base of thorax, tibiae and antennae diluted with red; a wide fascia and apex of elytra dark flavous. Nitid. Thickly clothed with long pale setae, with joints 4 faintly, 5-11 thickly clothed with short adpressed pubescence.

Head narrowly but deeply channelled; antennal tubercles rather large, prominent; with large rough punctures. Antennae not quite reaching apex

of elytra; joint 2 very short, 3 longer than 1 or 4, very faintly armed. Prothorax with a strong transverse impression near apex, at base with a round impression; sides in front of middle notched, behind with a rounded projection; an elongate smooth node on disc, with four smaller ones arranged around it; punctures rather large and rough. Elytra elongate, parallel-sided to near apex, the latter obliquely truncated; an impression on base near shoulders, which are slightly raised and smooth; punctures large and round, becoming much finer and less distinct near apex. Under surface with a few scattered punctures. Length, 12 mm.

Hab.—Victoria: Gypsum (C. Oke) in November, attracted to light.

Apex of elytra being truncate will, *inter alia*, separate this species from *dixoni*, while the apex not being armed will distinguish it from *tatei*. The black markings on the elytra are: a round scutellar patch, narrowly continued across base to sides, epipleurae, a round spot on either elytron at basal third, and a sinuate fascia at apical third.

Named after Mr. D. Best, a most enthusiastic and successful breeder of longicorn beetles.

Type in author's collection.

Chrysomelidae.

MONOLEPTA JUCUNDA, n. sp.

Flavous and black.

♂. Head with a strong curved interocular impression, lightly dilated forward in centre. Eyes rather small but prominent. Antennae moderately stout, just passing hind coxae; second and third joints equal, fourth longer, eleventh sharply pointed. Prothorax transverse, sides rounded, hind angles rounded off; with minute indistinct punctures. Elytra subelliptic; punctures rather small and close, but sharply defined. Epipleurae abruptly narrowed near hind coxae. Basal joint of hind tarsi nearly as long as the rest combined. Apex of abdomen with two narrow impressions on under surface.

♀. Similar to the ♂, but without impressions on the abdomen and the apex more convex beneath. Length, 3-3·50 mm.

Hab.—Victoria: Fern Tree Gully, Emerald, Warburton (C. Oke), in grass.

The head, antennal joints 6-10, a subtriangular blotch on sides of pronotum and one on disc (which is more or less distinct), scutellum, a fairly wide transverse mark on base (but not reaching sides) and suture (not quite reaching apex) towards apex, on sides, with a horseshoe-shaped mark, black; the 1st-4th and 11th (extreme tip infuscated) joints flavous, the others black or almost so; the sternum and ventral segments of abdomen infuscated in some places.

A pretty little species allied to *aberrans* Lea, but with different markings, and the second and third joints of antennae of equal length. Most of the specimens have an indistinct or vague blotch on middle of pronotum, but on one ♀ it is quite distinct and is almost a medial vitta.

Types in author's collection.

MONOLEPTA THEMEDICOLA, n. sp.

Flavous; a spot at base of head, a medio-apical spot and sides of pronotum, a spot on base (one-third from scutellum towards sides), shoulders and inner edge of epipleurae, 2 premedian and 3 post-median spots of elytra, and extreme

base of hind tarsi, black; antennal joints 4-11 with an infuscated mark near their apices.

Head with a narrow but fairly deep procurved interocular impression, with a small impression in front, a few punctures behind. Eyes large and prominent. Antennae with the second joint short, third a little longer, the others much longer. Prothorax nearly twice as wide as long, sides almost straight, base rounded, apex straight; transverse impression feebly indicated towards sides; punctures fine and close but sharply defined. Elytra long, subparallel-sided to near apex; punctures a little stronger than on pronotum; epipleurae narrowed before hind coxae. Basal joint of hind tarsi a little more than once and one-half the length of the rest combined.

Hab.—Victoria: Evelyn, Fern Tree Gully (C. Oke), on *Themeda triandra* Forst.

Close to description of *bivitticollis* Lea, but differs in the shape and punctures, while the markings on the elytra are certainly different. Only two vittae on prothorax, with its sides not rounded, will separate it from *trivitticollis* Lea. The elytral markings are not as noted for *figurata* Weise, and *megalops* Lea, also the vittae on prothorax and the close punctures on elytra separate it from the latter. The hind angles of the prothorax are produced into a minute tooth, but this is not visible from some angles.

Type in author's collection.

THE LORANTHACEAE OF AUSTRALIA. Part vii.

By W. F. Blakely, Assistant Botanist, National Herbarium, Sydney.

(Plates i-ix.)

[Read 28th March, 1928.]

II. 1. Viscoideae-Korthalsellineae.

Engler, Engl. et Prantl., *Pflzfam.*, Nachtr., 1897, 137; *Bifariées* Van Tiegh., *Bull. Soc. bot. France*, xliii, 1896, 162.

Perianth single. Flowers unisexual. Placenta central; embryo-sac oblong or U-shaped. Anthers two-celled, usually dehiscent by a terminal orifice in the Australian species.

5. Korthalsella Van Tiegh.

Bull. Soc. bot. France, xliii, 1896, 83; Engler, Engl. et Prantl., Nachtr., 138.

Flowers unisexual. Calyx absent or inconspicuous. Corolla regular. Male flowers trimerous, the petals persistent, valvate, triangular, concave and somewhat gibbose. Anthers (3), forming a sessile globose mass in the centre of the perianth, two-celled, usually dehiscent by a single central pore. Female flowers trimerous, the petals persistent, regular, valvate, incurved in all the Australasian species. Ovary inferior; style very short, included; stigma thick, pulvinate. Fruit baccate, viscid, pear-shaped or ellipsoid, crowned by the petals. Seeds albuminous; embryo 1, rarely 2, terete or compressed; cotyledons membranous, unequal. Leafless parasitic shrubs; branches opposite, nodose, the internodes angular, terete, or broadly compressed, nerveless or venulose. Leaves reduced to microscopic stipular scales. Inflorescence axillary, consisting of a simple floral band forming a cushion-like receptacle on the shoulders of the internodes. Flowers usually surrounded for nearly half their length by moniliform, crystalline, variously coloured cilia.

The common Australian species, formerly known as *Viscum articulatum* Burm., is included under *Pseudixus japonicus* by Hayata (*Ic. Pl. Form.*, v, 1915, 187).

In the absence of the original description of *Korthalsella* Van Tiegh., and *Bifaria* Van Tiegh., I have decided to follow Engler and take up the name *Korthalsella* in preference to *Pseudixus* Hayata, as the disposition of the anthers is not quite clear to me. Apparently Hayata is also dubious as to their arrangement, for he says "*Bifaria* seems to have male flowers with stamens opposite to the perianth-lobes, as is the case with *Korthalsella*".

Assuming that Van Tieghem had inaccurately described the anthers of *Korthalsella* or *Bifaria*, it would not be admissible on that account to set aside his genus and establish a new one.

In addition to the Australian, Lord Howe, and Norfolk Island species, I have examined the anthers of *K. salicornioides* Van Tiegh., from New Zealand, and also *Korthalsella* (*Viscum*) *pendulum* A. A. Heller, and a specimen labelled

Viscum articulatum from Hawaii, all of which, to my mind, have the same staminal arrangement.

The last-mentioned plant must not be confused with the Australian plant, as it is quite different, particularly in the complanate branches.

I have not seen the male flowers of *K. Lindleyi* from New Zealand, but the female flowers and the fruits differ only in size from those of all the other species referred to.

I have given considerable attention to *Korthalsella articulata* which is very closely allied to *Pseudixus japonicus* Hayata in nearly all the essential characters, but it appears to differ somewhat widely in the internodes, and to some extent in the anthers. It must be borne in mind that the anthers are the deciding factor between *Korthalsella* and *Pseudixus*, and, owing to their minuteness, they are very difficult to define.

Of the numerous male flowers examined in all stages of development, I was unable to find one with the anthers clearly separated along what appears to be the sutural line; but numerous anthers showed a perfectly defined central pore or orifice, without the slightest sign of cleavage of the suture. On the other hand, when in a dry state, the connate anthers separate in whatever direction the needle is directed, more readily than along the sutural line. The same result was noted when the flowers were boiled. In fact, I can come to no other conclusion but that the majority of the anthers examined were dehiscent through a terminal orifice.

The camera-lucida drawing, by Miss M. Flockton, depicts a male flower artificially opened, with two-celled anthers, without the broad receptacle shown by Hayata. It is obvious that the Japanese plant has the anthers more fully developed than the Australian plant.

Sect. Bifaria Engler.

Engl. et Prantl, Nachtr., 138.—*Bifaria* Van Tiegh., *Bull. Soc. bot. France*, xliii, 1896, 164.

Floral bracts on one plane. Flowers surrounded by minute moniliform cilia. Internodes cylindrical or compressed.

Australian Species.

i. Internodes longer than broad, usually three-nerved, contracted at both ends. Flowers of the old branches usually encircling the internodes ... 1. *K. articulata.*
ii. Internodes broader than long, 3- to 7-nerved, not contracted at the ends. Flowers on the shoulders of the internodes only ..... 2. *K. australis.*

Island Species.

i. Internodes 20-25 cm. long, with 3 scarcely prominent nerves ..... 3. *K. Howensis.*
ii. Internodes more than 25 cm. long, with 3-7 prominent nerves .... 4. *K. opuntioides.*
iii. Internodes 1-3 cm. long? ..... ? 5. *K. bigibba.*

The floral band of Viscum *and* Korthalsella.

The floral band or floral cushion of *Viscum* and *Korthalsella* is best described as a thin expansion of the upper margin of the internode which functions as a protection for the young shoots and flowers. It is considerably broader on the shoulders than in the middle, and usually forms a socket-like appendage over the shoulders of the internodes. In *Viscum* it is invariably a mere band, while in *Korthalsella* it expands into a cushion-like receptacle, closely packed with minute

moniliform, white or pink cilia, resembling a little mop, or the head of a diminutive Composite. Both the floral band and the floral cushion have much in common; they are not only the torus of the flowers, but also the growing point, for many young shoots spring from either of them, after the flowers and fruits have fallen, and more than one (perhaps several) generation of flowers originates upon them as in other shrubby plants that produce flowers on the old nodes annually.

1. KORTHALSELLA ARTICULATA (Benth.), n. comb. Plate i.

B.Fl., 1866, iii, 396; Mueller, *Report Burdek. Exped.*, 1860, 12, as *Viscum articulatum* (*non* Burm., *non* Franch., *non* Tate); Van Tiegh., *Bull. Soc. bot. Fr.*, xliii, 1896, 146, as *Bifaria breviarticulata*; Engl. et Prantl., *Pflzfam.*, i, 1897, 138, as *Kortalsella breviarticulata* (Van Tiegh.); Bail., *Fl. Q'land*, v, 1384; *Com. Cat. Q. Plants*, 466, fig. 452.

Mueller did not describe his species, but accepted Dr. J. Hooker's decision that it was conspecific with *V. articulatum* Burm. (*Fl. Ind.*, 311). He also expressed the opinion that "it differed in no particular from *V. moniliforme* Blume, as illustrated in the Spiciligium Neilgherrense, t. 87."

Bentham's description is the first on record and as it is somewhat imperfect I am obliged to describe the plant more fully:—Compact plants from 3 to 24 inches in diameter, somewhat erect when young, but soon forming dense conglomerate pendulous masses; union fusiform, branches compressed, articulate, the old ones semi-terete, especially at their junction with the host; internodes thick, cuneate oblong, coriaceous, 2 to 4 cm. long, 1 to 1½ cm. broad, 1- to 3-nerved, with flexuose wrinkles between them, usually of a yellowish-brown colour; stipules small, persistent, acute, sometimes completely concealed by the floral band or cushion which is persistent on the upper portion of the internode; at first it is bandlike, but with the development of the branch, which may extend over a number of years, it forms a pulvinate projection on the shoulders of the internodes. Flowers few or numerous within the floral cushion, surrounded by moniliform, crystalline cilia, which often change from white to pink, or in some specimens a purple-brown colour, which no doubt, is due to climatic conditions. Sometimes the flowers are nearly all males, especially on the ends of the branches, but usually the percentage of females greatly exceeds that of males.

Male flowers globose, stipitate or turbinate, about ¾ mm. in diameter, three-lobed, the lobes broadly and obtusely triangular to nearly orbicular, concave, somewhat gibbose on the back, persistent. Anthers connate, globose or depressed-globular, in the centre of the flower, marked by six very faint lines, three of which are slightly more prominent than the others and correspond to the valves of the two-celled anthers, which sometimes open very imperfectly along the suture, alternately with the petals, but apparently they are more often dehiscent by a central pore. Female flowers cylindrical or pear-shaped, longer than the males, crowned with three persistent, very short, broad, triangular, scarcely concave lobes; style very short; stigma pulvinate. Fruit pear-shaped, 2 to 3 mm. long, opening apically; epicarp thick, yellowish; seeds compressed, broadly cordate or reniform, ½ mm. long, covered with a white reticulate membrane; endosperm green; hypocotyl green, terete; disc conical; cotyledons hyaline or rudimentary (only two observed), unequal, usually acute or the longer more acute than the other, withdrawn from the endosperm when germination takes place.

K. articulata appears to be self-parasitic in the seedling stages only; numerous

seeds germinate on the parent plant in profusion, but do not thrive after attachment takes place. I have been unable to find any large examples of self or secondary parasitism on the parent plant, but a large number of seedlings are seen in various stages of development infesting the parent which do not seem to pass beyond the germinating stage.

Synonyms:—*Viscum articulatum* F.v.M. (also Benth., *non* Burm., *non* Franch, *non* Tate), *Bifaria breviarticulata* Van Tiegh., *B. rubra* Van Tiegh., *Korthalsella rubra* (van Tiegh.) Engl.

Range.—South Australia: Lake Eyre Basin (Professor Tate, Trans. Roy. Soc. S.A., 1887/88, xi, p. 94), near Ooldea Soak, on *Acacia ramulosa* (Prof. J. B. Cleland. Aug., 1922).

Western Australia: Messmate Creek, Parker's Range, on *Buchannia oblongifolia.* Plants greenish-yellow, flowers greenish. Fruit yellow, W. V. Fitzgerald, *Proc. Roy. Soc. W.A.*, iii, 1918, 34. I made application for the loan of this specimen, but was informed that the genus was not represented in the Western Australian Herbarium.

New South Wales: Mount Dromedary; Kiama, on *Doryphora sassafras*; Mt. Kembla, on *Ceratopetalum apetalum*; road to Mt. Irvine and Mt. Wilson, on *Polyosma Cunninghamii*; Blow Clear State Forest, 10 miles N. of Bogan Gate, on *Geijera parviflora*; Trundle, on "Wilga"; Weston, on *Geijera parviflora*; Wingham, on *Callistemon viminalis*; Manning River, on *Callistemon viminalis*; Harrington Inlet, on *Eugenia Smithii*; Port Macquarie, on *Eugenia Smithii*, Page River, on *Geijera parviflora*; Clarence and Richmond Rivers, Dr. Beckler, quoted by Bentham; Coonamble. Said to be killing the "Wilga", *Geijera parviflora*; Porcupine Ridge, Gunnedah, on *Geijera parviflora*; "Myall Creek, North West of the Liverpool Range, on *Capparis Mitchelli*, also on "Wilga", *Geijera parviflora.* There were dozens of trees of each genus affected" (G. Burrow); Plains near Baradine, on *Geijera parviflora*; Baan Baa, on *Geijera parviflora*; Narrabri, on *Santalum* sp.; Warialda and Goondiwindi districts, growing on several kinds of shrubs (A. D. Porter).

Queensland: Brisbane River, on *Eugenia* sp.; Moreton Bay (F. Mueller), quoted by Bentham; Enoggera (F. M. Bailey); Johnston River, on *Eugenia* sp. (Dr. T. L. Bancroft).

Affinities.—All the Australian species bear a general resemblance to one another in the mode of growth, and in the principal morphological characters. The degree of difference between them is mainly limited to the minor characters, which are, in themselves, subject to considerable variation. The internodes afford a ready means of discrimination between the various species, which at first appear to offer but little assistance to the beginner, but eventually the facies of each species can be readily detected.

Differing from *K. Howensis* in the much flatter and thinner internodes and in the ciliate young shoots, and also to some extent in the more gibbose male flowers.

Hosts.—Santalaceae: *Santalum* sp. Monimiaceae: *Doryphora sassafras* Endl. Capparidaceae: *Capparis Mitchelli* Lindl. Saxifragaceae: *Polyosma Cunninghamii* J. J. Benn. Cunoniaceae: *Ceratopetalum apetalum* D. Don. Rosaceae: *Prunus* sp. Garden peach. Leguminosae: *Acacia ramulosa* W. V. Fitz. Rutaceae: *Geijera parviflora* Lindl., orange tree. Anacardiaceae: *Buchannia oblongifolia.* Myrtaceae: *Eugenia Smithii* Poir. and var. *minor* Maiden and Betche. Myoporaceae: *Myoporum Mitchelli* Lindl.

2. KORTHALSELLA AUSTRALIS (Bail.), n. comb. Plate ii, A.

Bail., *Q'land Agr. Journ.*, xxvi, 1911, 199; Bail., *Com. Cat. Q'land Pl.*, 466, fig. 453, as *Viscum australe.*

The following is the original description: "Growth of plant erect, the main stem very short, sometimes only a few lines, from this arise one or more flat, mostly 3 nerved, coriaceous branches, 1½ to 2¼ ins. long, 3-6 lines broad, bluntly lanceolate in form, bearing here and there along the margin shorter but similar shaped branchlets. The nodal cluster small, seldom showing any marks or lines to the opposite cluster, and the indentation in which the clusters of flowers is seated is often almost imperceptible, thus in this one can scarcely speak of internodes. Inflorescence much the same as *V. articulatum* Burm., Benth. Fl. iii, 396".

Supplementary notes to the description.—Internodes, 10-15 mm. long, 10-20 broad, 3- to 7-nerved, the nerves fine. Inflorescence only on the shoulders of the internodes, the floral cushion about 5 mm. long, flowers numerous, the females far more numerous than the males. Male buds turbinate, clavate, or subglobose, attenuated at the base into a compressed, sub-angular pedicel, the whole about ¾ mm. long, just exceeding the cilia; they are more often around the edge of the floral cushion than in the centre; petals 3, persistent, smooth or gibbose, connate; receptacle small; petals broadly triangular, thick, concave, the front or central petal more flexible and more lip-like than the others. Anthers synantherous, forming a globular mass over the centre of the receptacle, ¼ mm. in diameter, two-celled, dehiscent by a single central pore. Female buds elliptical, or pear-shaped, usually half imbedded in the moniliform cilia, tri-merous; petals very small, triangular, incurved, persistent on the ripe fruit. Style minute; stigma large, pulvinate. Fruits yellowish, pyriform, about 2 mm. long, 1½ mm. in diameter; seeds smooth, cordate; embryo semi-terete; cotyledons rudimentary.

Synonym:—*Viscum australe* Bail.

Range.—Up to the present the species is known only from Queensland: Warwick, parasitic on *Heterodendron diversifolium* (F. C. Hall, vide C. T. White, Queensland Naturalist, v, ii, 1915, p. 32, as *V. australe* Bail.); Toowoomba, on *Carissa Brownii* (H. A. Longman); Crow's Nest, 70 miles W.N.W. of Brisbane, and about 20 miles N. of Toowoomba, on Mandarin Orange tree (E. W. Peechy, No. 1066, 18th May, 1896. The type); Main Range, near Gowrie, on *Croton insulares* (F. M. Bailey, cotype).

Affinities.—It appears to be more closely allied to *Viscum pendulum* Heller, from Hawaii, than to its Australian congener. The Hawaiian plant is considerably larger and has broader internodes; the floral cushions are also larger. Some forms of *K. opuntioides* have broad internodes, but they differ in being thicker and more oblong than those of *K. australe*; on the other hand, there is no difference in the female flowers, but the male buds present slight variations.

Hosts.—Rutaceae: Mandarin Orange. Euphorbiaceae: *Croton insulares* Bail. Sapindaceae: *Heterodendron diversifolium* F.v.M. Apocynaceae: *Carissa Brownii* F.v.M.

3. KORTHALSELLA HOWENSIS (Van Tiegh.) Engl. Plate ii, B.

Engler et Prantl, Nacht. i, 1897, 138; Moore, Lord Howe Is., Off. Report 24, 1870, as *Viscum opuntioides* (*non* Bauer, *non* L., *non* Heyne ex DC.); Muell., Fragm., ix, 1875, 77, as *Viscum articulatum* (*non* Burm.); Muell., ibid., as *V. distichum* (*non* Endl.); Tate, *Macleay Mem. Vol.* LINN. SOC. N.S.W., 1893, 219, as *V. articulatum* Burm.; Hemsl., *Ann. Bot.*, x, 1896, 250, as *V. articulatum* Burm.; Van Tiegh, *Bull. Soc. bot. Fr.*, xliii, 1896, 164, as *Bifaria Howensis*; Oliv., *Trans.*

Proc. New Zeal. Inst., xlix, 1917, 115, as *K. articulatum* and *K. articulata.* I have not seen Van Tieghem's description.

Compact plants, 2-6 inches in diameter (J. L. Boorman). Branches divaricate, usually pendulous; internodes yellowish, terete, convex or compressed, coriaceous, ovate to cuneate, with one to three prominent nerves, and two to four finer nerves in large specimens, 12-30 mm. long, 5-15 mm. broad. Young shoots glabrous. Floral cushion on the shoulders of the internodes, not united in the middle, the floral band ¼ to 2 mm. deep, ciliate bracts very short and dense, usually very dark in colour on the advanced or old plants, white or pink on young plants. Flowers yellowish, single or in pairs on the young shoots, forming dense clusters on the old branches within the floral cushion, the females exceeding the males both in size and number. Male buds about ½ mm. long, exceeding the cilia, clavate, turbinate, sometimes flat-topped, usually pedicellate, the pedicel thick or thin according to the shape of the bud, compressed or angular, petals 3, coriaceous, smooth or gibbose, usually triangular and very concave, persistent. Anthers synantherous, globose, connate in the centre of the receptacle, tardily separating into three two-celled anthers, but more constantly dehiscent by a central pore. Female flowers indistinguishable from the buds, pyriform, about ¾ mm. long, the minute persistent petals triangular, obtuse; the pulvinate stigma not exceeding them, and much darker in colour. Fruit yellowish, elliptical, or usually pyriform, about 2 mm. long; epicarp thick; seed narrow, cordate, smooth, dark green; embryo terete, obtuse, embryonic cotyledons obtuse, rudimentary. Hypocotyl in the germinating seeds very slender.

Synonyms: *Viscum opuntioides* Moore (*non* Bauer, *non* L., *non* Heyne ex DC.), Lord Howe Off. Rept., *Viscum articulatum* F.v.M. (*non* Burm.), *Fragm.*, ix, 1875, 77; *Viscum distichum* F.v.M. (*non* Endl.), ibid.; *Bifaria Howensis* Van Tiegh., *Bull. Soc. bot. France*, xliii, 1896, 164; *Korthalsella articulatum* Oliver (*non* Burm., *non* Van Tiegh.), *Trans. Proc. New Zeal. Inst.*, xlix, 1917, 115; *Korthalsella articulata* Oliv., ibid., 135.

The first published record of this species is that of Moore in his Lord Howe Island Official Report, 1870, p. 24, which is as follows: "A singular plant of the Mistletoe kind. *Viscum opuntioides*, found also in Norfolk Island was observed growing in considerable quantities, but only upon two kinds of trees, *Hemicycle* and *Elaeodendron*".

Other published records and references are as follows: *Viscum articulatum* Burm. f., *V. moniliforme* Blume, Bijdr., p. 667. Wight Ic. tt. 1018, 1019, *V. opuntioides* Moore, Rept. 2 (*non* L.) (vide Hemsley, *Ann. Bot.*, x, 1896, 250).

"Very abundant on the Island. Without special search, I observed it on *Elaeodendron curtipendulum*, *Cryptocarya triplinervis*, *Hemicyclia australasica*, *Coprosma putida* and *Pimelea longifolia*". (J. H. Maiden, These Proc., xxxiii, 1898, 134).

R. Tate (Macleay Memorial Volume, p. 219) records it as *V. articulatum* Burm.

Northern Lookout, on *Olea paniculata*, Rev. W. W. Watts, August, 1911, in National Herbarium, Sydney.

Korthalsella articulata (Burm. f.) Van Tiegh. Parasitic on trees in lowland forest; abundant; host *Ochrosia elliptica.*

W. R. Oliver in the Vegetation of Lord Howe Island, in Trans. Proc. New Zealand Institute, xlix, 1917, 105 and 135.

"This parasite is not so destructive on the lives of the Tamana, *Elaeodendron curtipendulum* as it is to the Blackbutt. High up on the Scaly Bark, *Acicalyptus*

Fullagrii, a few isolated plants were noted, but nothing as prevalent as those growing on the Blackbutt. I am inclined to the belief that Tamana and Blackbutt, *Cryptocarya triplinervis* are the favoured hosts of this particular parasite" (J. L. Boorman, May, 1920; field note in National Herbarium, Sydney.)

Affinities.—Very closely allied to *K. articulata* in the internodes and female flowers and fruits, but distinguished from it in the glabrous young tips, differently shaped male buds, and also in the shape of the seeds. The moniliform cilia appear to be longer in the Australian plant. Some of the internodes of this species are not unlike those of *K. Lindleyi*, a New Zealand species.

Hosts.—Lauraceae: *Cryptocarya triplinervis* R. Br.; Euphorbiaceae: *Hemicyclia australasicus* J. Muell.; Celastraceae: *Elaeodendron curtipendulum* Endl.; Thymeleaceae: *Pimelea longifolia* Banks and Soland.; Myrtaceae: *Acicalyptus Fullagrii* F.v.M.; Oleaceae: *Olea paniculata* R. Br.; Apocynaceae: *Ochrosia elliptica* Labill.; Rubiaceae: *Coprosma putida* F.v.M.

4. KORTHALSELLA OPUNTIOIDES (Bauer), n. comb. Plate iii.

F. Bauer, *Ill. Pl. Norf. Is.*, 1804-5, t. 200, as ? *Viscum opuntioides* Forst.; Endl., *Prod. Fl. Norfae*, 1833, 61, as *V. distichum*; Walp., *Rep. Bot. Syst.*, ii, 1843, 438; Tate, *Macleay Mem. Vol.*, 1893, 218, as *V. articulatum* Burm.; Van Tiegh, *Bull. Soc. bot. Fr.*, xliii, 1896, 164, as *Bifaria disticha*, *B. bigibba*; Engler, Engl. et Prantl., *Pflz.*, Nachtr., i, 1897, 138, as *K. disticha*; Laing, *Trans. Proc. New Zeal. Inst.*, xlii, 1915, 24, as *K. articulatum* (Burm.) Van Tiegh.

As far as can be ascertained, Bauer did not describe this species, but figured it in detail under the name of *Viscum opuntioides* Forst. Apparently he had mistaken the author, as I am unable to find a reference to Forster's species. Endlicher, however, published the following description in his Prodromus Florae Norfolkieae, p. 61.

"Aphyllum distiche-ramosum, ramis compressis articulatis, articulis ovato-oblongis, longitudinaliter costato-striatis, infirmis teretiusculis, reliquis foliaceo-compressis, caulinis duplo v. triplo, ramiis quadruplo quintuplove latitudine longioribus, floribus, ad articulorum apices glomeratavertillatis, vagina brevissima truncata sustentis."

I have not seen Van Tieghem's description. The following is drawn up from specimens collected by Mr. J. H. Maiden.

Rigid divaricate plants, 6 to 12 inches in diameter; branches yellow, rather sparingly branched, the apex of the young shoots almost glabrous; internodes oblong, compressed, biconvex, those in the vicinity of the fusiform union terete, 10 to 30 mm. long, 5 to 10 mm. broad, obscurely uninerved or more often nerveless, the edges rather sharp. Inflorescence of the advanced internodes completely encircling them, the floral cushion 3-5 mm. in diameter, almost black in dried specimens (fresh specimens not seen); flowers numerous, 15 to 30 in each cushion or fewer in the young internodes, the females usually uppermost, and apparently developing first. Bracts moniliform, crystalline, pale pink to purple-brown, about half the length of the flowers. Male flowers yellow, turbinate or similar to those of *K. articulata* and *K. Howensis*. Female flowers yellow, pear-shaped, similar to the above species. Fruit pear-shaped or elliptical, ¾ mm. long; epicarp very thick; seeds broadly cordate, ¾ mm. long, ¼ mm. broad; embryo terete; embryonic cotyledons obtuse.

Synonyms.—*Viscum opuntioides* Bauer, *Illust. Pl. Norf. Is.*, t. 200 (*non* Heyne ex DC., *non* L., *non* Forst., *non* Moore); *Viscum articulatum* Tate (*non* F.v.M.,

non Burm.), *Macleay Mem. Vol.*, 1893, 219; *Bifaria disticha* Van Tiegh., *Bull. Soc. bot. Fr.*, xliii, 1896, 164; *Korthalsella disticha* (Endl.) Engl., Engler et Prantl, *Pflz.*, Nacht., i, 1897, 138. R. M. Laing, *Trans. Proc. New Zeal. Inst.*, xlvii, 1915, 24, records it as *Korthalsella articulatum* (Burm.) Van Tiegh.

Range.—It appears to be found over the whole of the island. Three specimens collected by J. Robinson show marked variation, viz.: (1) Internodes up to 7 cm. long and 2 cm. broad, the central nerve very prominent on one surface only, the intermediate nerves very fine (collected Sept., 1898); (2) No. 26, internodes terete to compressed-convex, 1-3 cm. long, 4 mm. broad. As this specimen is broken up, it is difficult to say whether it is a form of the preceding or a distinct species; (3) No. 227, internodes compressed, slightly convex, 2-4 cm. long, 7-17 mm. broad, the broadest five-nerved, and the narrow ones faintly three-nerved (collected 1902). Mr. J. H. Maiden, These Proceedings, xxviii, 1903, 715, 770 (1903) has the following note: "The joints are as much as 1½ in. across. It is very abundant on the Island, being very common on *Baloghia lucida*, the Bloodwood. The only other native tree on which I observed it is *Xanthoxylon Blackburnia*, but further search should be made. As regards introduced plants, it is common on Lemons and kills Peach trees. In fact it is a pest in orchards". Mr. Maiden's specimen is similar to No. 1.

Affinity.—*K. opuntioides* appears to be a much larger plant than either *K. Howensis* or *K. articulata*; it also differs from them in the rigidity of the branches, more venulose internodes, and in the broadly cordate seeds.

Hosts.—Rosaceae: *Persica vulgaris* L.; Rutaceae: *Xanthoxylon Blackburnia* Benth., *Citrus Limonum* L., *C. aurantium* L.; Euphorbiaceae: *Baloghia lucida* Endl.

5. Korthalsella bigibba (Van Tiegh.) Engler.

Engler, *Bull. Soc. bot. France*, xliii, 1896, 164, as *Bifaria bigibba*. I have not seen a description of this species, and therefore I am unable to say definitely what it is, or whether it is conspecific with *K. opuntioides*.

On Plate iii, figures 12 and 13 depict a very narrow form which may be referable to *K. bigibba*. It is the most extreme form that I have seen from Norfolk Island, and probably a distinct species. Unfortunately the material is imperfect; only female flowers are available, and they are the same as in all the other species. The internodes are almost terete, to compressed-convex, 1-3 cm. long, 4 mm. broad.

Synonym.—*Bifaria bigibba* Van Tiegh.

II. 2. Viscoideae-Visceae.

Engler, Engl. et Prantl, *Pflzfam.*, iii, 1889, 190; Nachtr., 1897, 137. *Viscées* Van Tiegh., *Bull. Soc. bot. France*, xliii, 1896, 185.

Placenta basal. Anthers with four or numerous chambers, dehiscent by pores.

(*a*) Anthers not united with the petals, opening at the top by an oblique fissure. Hoary or golden stellate shrubs ..... *Notothixos.*

(*b*) Anthers adnate to the petals, many-chambered. Green leafy or leafless shrubs. ..... *Viscum.*

6. Notothixos Oliv.

Journ. Linn. Soc., vii, 1864, 103; Benth., *B. Fl.*, iii, 396; Benth. et Hook, f., *Gen. Pl.*, iii, 214; Engler, Engl. et Prantl., *Pflzfam.*, iii, i, 192; Nachtr., 139; Moore et Betche, *Handbk. Fl. N.S.W.*, 227; Mueller, *Fragm.*, ii, 109; Bail., *Q'land Fl.*, v, 1382.

Flowers unisexual. Calyx border quite inconspicuous. Petals 4, rarely 3 or 5, persistent. Anthers with a very short filament, inserted between the base of the petals and the quadrangular disc, transversely bilobed, more or less reniform, obscurely chambered, dehiscent by pores. Stigma sessile, fruit a one-seeded ovate, or globose berry.

Parasitical dichotomous shrubs, more or less covered with a golden or hoary glandular puberulence, rarely at length, nearly glabrous. Leaves opposite, flat or concave, three- or five-nerved, but the nerves often obscure, usually glabrous and shining above, golden or hoary beneath. Stipules minute, rigid, acute. Flowers minute, sessile in little compressed pedunculate heads, solitary or severed on a common terminal peduncle, the cymule androgynous.

The structure of the male and female flowers is nearly the same in all the species, but the female flowers are more numerous than the males, which are difficult to detect even in the living specimens.

"Candelabra-hairs with unicellular tiers are formed in *Notothixos*, according to Engler. These hairs consist of a row of short and somewhat ventricose, thin walled cells, divided into 4 or more rays" (*vide* Solereder, ii, p. 727).

The genus, at one time, was believed to be confined to Australia; but with the advancement of the botanical survey of the world's flora, its range has been considerably extended. There are four species endemic to Australia, three to the Philippine Islands, while British New Guinea, Ceylon and Malay, have each one representative, making a total of 10 species.

The Australian species are confined to the coastal area of New South Wales and Queensland, and they are invariably parasitic on another member of the same Family.

Notothixos differs from *Viscum* mainly in the hoary or golden vestiture, and in the shortly stipitate pouched anthers, while the perianth lobes are, without exception, persistent.

Synonym.—*Tupeia*, Mueller, *Journ. Linn. Soc. Lond.*, ii, 1858, 156.

Sect. Eunotothixos Van Tiegh.

Bull. Soc. bot. France, xlii, 1896, 187, Engler, Engl. et Prantl, *Pflzfam.*, iii, i, 192; Nachtr., 139.

Inflorescence racemose or cymose, the flowers disposed on shortly pedunculate, opposite clusters along the elongated common peduncle, or in short, usually deflexed cymules of three to nine flowers. Leaves usually large, three- to five-nerved, hoary or golden pubescent underneath.

Inflorescence, racemose or cymose. Leaves quinque-nerved.

i. Inflorescence racemose. Leaves more or less hoary or nearly glabrous, quinque-nerved, broadly oblong to lanceolate, 4-10 cm. long ..... 1. *N. cornifolius.*

ii. Inflorescence cymose. Leaves tri-nerved. Cymes elongated. Leaves golden pubescent, 7-13 cm. long ..... 2. *N. leiophyllus.*

iii. Cymes short. Leaves 2-4 cm. long ..... 3. *N. subaureus.*

iv. Leaves hoary ..... var. *cinera.*

Sect. Pencixos Van Tiegh.

Engler, Engl. et Prantl, l.c.

Flowers in triads, the short peduncle bearing three almost sessile flowers. Hoary plants with small cuneate or spathulate leaves.

Flowers in triads.

1. Leaves small, hoary, cuneate ..... 4. *N. incanus.*

1. NOTOTHIXOS CORNIFOLIUS (A. Cunn.) Oliv. Plate iv, B.

Journ. Linn. Soc., vii, 1864, 103; Benth., *B. Fl.*, iii, 397; Ettings., *Uber die Blatts. der Lor.*, tab. iii, Figs. 16, 17, p. 7, as *Phoradendron xanthophyllum* A. Cunn.: Baker, PROC. LINN. SOC. N.S.W., [2] ix, 1894, Plate xi, Fig. iv, p. 158; Bail., *Fl. Q'land*, 1383; Engler, Engl. et Prantl., *Pflzfam.*, iii, i, 192; Nachtr., 139; Moore and Betche, *Fl. N.S.W.*, 227.

The following is the original description:—"Paniculis terminalibus, floribus in capitulis 5-9 floris patentim pedunculatis bibracteolatis digitatim dispositis, foliis obovato lanceolatis v. obovatis v. lanceolatis, obtusis deinde emarginatis retusive glabris glabrescentibusve. *Viscum cornifolium* et *V. xanthophyllum* A. Cunn. M.S. Hab.: Hunter River and Liverpool Plains".

The following is a more detailed description:—Robust shrubs; union ball-like; the young plants hoary and sometimes golden tomentose, the adult foliage almost glabrous; branches terete, pendulous; internodes 2-10 cm. long; leaves obovate oblong to oblong-cuneate or oblique, obtuse, sometimes thick and almost elliptical, narrowed into a short petiole, three- to five-nerved, mostly 1½ to 4 inches long; stipules scarcely conspicuous, but always present on the young branches, acute, concave, villose inside. Flower heads several, opposite, in pairs in a terminal or axillary raceme, sometimes exceeding the leaves, with minute bracts under the short pedicels and under the heads. Flowers sessile in the heads, the female 4-5 mm. long, the males 2-3 mm. long, one or two in the female cymule, but sometimes forming independent cymules in the upper portion of the raceme. Anthers uniform, stipitate, smaller than in *N. incanus* and somewhat broader. Female flowers cylindrical, urceolate, the petals triangular acute; style broad, expanded into a two-lobed stigma. Fruit urceolate, 7-8 mm. long, slightly scurfy; seeds flat, enclosed in a strongly reticulate membranous sac surrounded by copious viscin which hardens and gives the seed a winged appearance. Hypocotyl slender, terete. Endosperm green.

This species is sharply separated from all the others by the racemose inflorescence and the large quinquenerved leaves.

Synonyms.—*Viscum xanthophyllum* A. Cunn., *Viscum incanum* Hook. var. *racemosum* Mueller (in herb.), *Phoradendron xanthophyllum* A. Cunn.

Range.—*New South Wales*: Burrinjuck, on *Brachychiton populneus*; Port Jackson (J. D. Hooker), quoted by Oliver, l.c.; Rylstone; Goulburn River; Taloobie, near Bylong Creek, on *Sterculia diversifolia*; Upper Hunter (A. Cunningham), quoted by Oliver, l.c.—this is a type locality; Warrah, on *Brachychiton populneus*, leaves broadly lanceolate-acuminate; Liverpool Plains (A. Cunningham), quoted by Oliver, l.c., a type locality; Coramba—flowering branch 2½ ins. long; Clarence River (this specimen is labelled *Viscum incanum* Hook. var. *racemosum* F. Mueller in Mueller's handwriting, it is typical *N. cornifolius*); Lismore (the leaves are more acute than in any other specimen, otherwise the same); Richmond River. Queensland: Brisbane River and Moreton Bay (A. Cunningham, and Fraser), quoted by Bentham, l.c.; Kelvin Grove; Three Mile Scrub; Buderim Mountain, on *Casuarina* trees, common; Enoggera.

Hosts.—Casuarineae: *Casuarina* sp.; Sterculiaceae: *Brachychiton populneus* R. Br.

Var. ANGUSTIFOLIA Oliv.

Journ. Linn. Soc., vii, 1864, 103, without a description.

The localities quoted are Brisbane River (Cunningham, Fraser); Moreton Bay (Cunningham).

Bentham apparently overlooked this variety in the flora as there is no reference to it by him.

So far, I have not seen any specimens which are suggestive of the variety from Queensland or New South Wales, and I have examined all the material in the Queensland Herbarium.

2. NOTOTHIXOS LEIOPHYLLUS K. Sch. Plate v.

Nacht. Fl. Deut. Schut., 1905, 260. Assimilis *N. cornifoliae* Oliv. et *N. subaurei* Oliv. at foliis jam majoribus ad 8 cm. longis et 4-5 cm. latis conspicue trinervis utrinque glabris innovationibus pulchre aureis diversus. Bismarck-Archipel. New Pommern (R. Parkinson).

Golden pubescent shrubs similar to *N. subaureus*. Leaves broadly lanceolate, acuminate, 4-12 cm. long, 3-6 cm. broad. Inflorescence racemose, bracteate; the keeled bracts supporting one or two cymules, the lower cymule of each pair, and sometimes the terminal ones of the raceme males. Female flowers more numerous than the males, cylindrical; style very short. Male flowers globose, about half the size of the females and somewhat similar to those of *N. subaureus*.

Affinity.—This species is closely allied to *N. subaureus* and at a casual glance would pass for a large-leaved form of that spcies, but apart from the leaves being larger they are more acuminate, and the inflorescence is more racemose than cymose, but the flowers and fruits are similar to those of *N. subaureus*.

Range.—Besides the specimen already quoted I have seen specimens from the following districts:—

Papua: Base of Owen Stanley Range (H. C. Forbes, recorded by Mueller in Descriptive notes on Papuan plants, 1885, p. 61, as *N. subaureus*). Leaves broadly elliptical to acuminate, 4-12 cm. broad.

Queensland: Rockingham Bay (Dallachy, in Melbourne Herbarium); Johnston River (H. G. Ladbrook, in Queensland Herbarium); also the following: Trinity Bay (F. M. Bailey). This and Dallachy's specimen are very near the type which came from New Pommern, Bismarck Archipelago.

Synonym: *Notothixos subaureus* F.v.M., *non* Oliver.

3. NOTOTHIXOS SUBAUREUS Oliv. Plate vi.

Journ. Linn. Soc., vii, 1864, 103; Benth., *B. Fl.*, iii, 397; Mueller, *Key Vic. Pl.*, i, 273; Baker, PROC. LINN. SOC. N.S.W., [2], ix, 1894, 158, Pl. xi, Fig. iii; Bail., *Fl. Queensland*, v, 1383; Engler et Prantl, *Pflzfam.*, iii, i, 192, et *Nachtr.* 139; Moore et Betche, *Fl. N.S.W.*, 227.

The following is Oliver's description:—"Floribus in capitulis terminalibus 5-9 floris, pedunculatis debracteolatis radiatum dispositis, pedunculis simplicibus geminatisve aut ternatimramosis, foliis elliptico ovalibus vel ovato-lanceolatis obtusis v. subacutis subtus pilis aureis stellatis pubescentibus (*Viscum subaureum*, F. Mueller)".

Supplementary description.—Small compact shrubs, usually parasitic on another member of the Family, rarely on other Families. Union globose, without adventitious roots, often forming dense masses from 6 inches to 3 feet in diameter. Leaves densely covered on the under surface with a golden stellate tomentum, the upper surface a dark glossy green, usually ovate or elliptical, sometimes shortly acuminate, narrowed into a distinct petiole, mostly 2-4 cm. long, triplinerved, the transverse veins somewhat prominent. Stipules very

small, acuminate, the first pair opposite, at the apex of the internode, more or less deciduous, the second pair 3-7 mm. above the node, usually alternate and persistent. Inflorescence cymose, densely tomentose, the common peduncle usually with three reflexed cymules, or sometimes consisting of a single cymule, secondary peduncles very short, the apex above the concave navicular bracts expanded into a flabelliform receptacle, on which the minute flowers are arranged in a single row around the edge, each in a separate depression of the flabelliform receptacle, all male or all female, or a large percentage of the cymules with both sexes, but the females usually predominant. Male flowers globose, sessile, the broad persistent petals longer than the basal portion. Anthers with very short filaments, inserted between the subquadrangular, depressed disc and the base of the petals reniform or pouched, opening by an oblique fissure, five- to nine-chambered, dehiscent by pores, the cells covered with a thin transparent membrane. Female flowers tetramerous, cylindrical, very shortly pedicellate, 2-3 mm. long; petals narrow, small, persistent; style very short. Fruits globose, 4-5 mm. in diameter, crowned by the petals, pale green or whitish, minutely tomentose. Seeds flat, hoary, 2-3 mm. long. Hypocotyl terete, green, exceeding the length of the seed; suctoral disc conical, sometimes acute, during the growing period before attachment with the host. Embryonic cotyledons minute, with a very small apicula, about $\frac{1}{2}$ mm. long. Primary leaves elliptical, similar to the adult leaves, and like them golden pubescent.

Synonyms.—*Viscum subaureum* F.v.M., *Viscum aureum* Woolls, *Viscum incanum* Hook., var. *subaureum* F.v.M.

Range.—New South Wales: It is very common from North Sydney to the Hawkesbury River, near Brooklyn, and is invariably parasitic upon both *Phrygilanthus* and the local species of *Loranthus*; Blaxland, on *Phrygilanthus eucalyptifolius*; additional northern localities are Gosford; Tuggerah Lakes, on *Loranthus Cambagei*; Belmont on *L. Exocarpi*; Manning River; Hastings River; Nundle; Tamworth, on *L. Miquelii* and *L. miraculosus*, var. *Boormani*; Ash Island; Ramornie, near Copmanhurst, on *L. alyxifolius*, *L. pendulus*, and *Viscum angulatum*; Lismore; Ballina; Tintenbar, on *Acacia* sp.; Richmond River; Tweed Heads, on *Tristania suaveolens*; Acacia Creek.

Queensland: It is very common around Brisbane and extends northwards as far as Kin Kin. At Toowong it was found growing on *Grevillea robusta*.

Affinities: Closely allied to *N. leiophyllus* K. Sch., and differing mainly in the smaller leaves, and shorter cyme. *N. subaureus* is also closely allied to *N. Malayanus* Oliv., but the fruits of the latter are cylindrical, not globose according to the figure in Hooker's Icones, third series, vi, t. 1519.

Hosts.—Loranthaceae: *Phrygilanthus celastroides* (Sieb.) Eichl., *P. eucalyptifolius* (Sieb.) Engl., *Loranthus congener* Sieber, *L. alyxifolius* F.v.M., *L. pendulus*, Sieber, *L. Miquelii* Lehm., *L. Cambagei* Blakely, *L. vitellinus* F.v.M., *L. Exocarpi* Benth., *Viscum angulatum* (Heyne) D.C.; Proteaceae: *Grevillea robusta* R. Br.; Leguminosae; *Acacia* sp.; Myrtaceae: *Tristania suaveolens* R. Br.

Var. CINERA, n. var.

Folia cinero-tomentose, haud aureis ut in *N. subaurei*.

Leaves and inflorescence the same as in *N. subaureus* but the vestiture is hoary instead of golden, and it is also minutely woolly, not stellate as in the species.

Range.—Kuranda, North Queensland (Rev. N. Michael). Mr. R. T. Baker, These PROCEEDINGS, 1894, 158, Plate xi, fig. iii, refers to a variety with silvery leaves. He says: "From the same locality (Lismore) as the previous variety (ii), [*N. subaureus*] but has larger leaves than i and ii, and there is a distinct departure from the golden tomentum to a silver sheen. It is also distinctly triplinerved, the transverse veins are distinctly prominent, and the leaf is also of a much thinner texture than forms i and ii. Sufficient specimens have been examined to show that it is no sport."

I have not seen Mr. Baker's specimen, and there is no outstanding character in the plant depicted by him to differentiate it from the normal *N. subaureus*. The chief distinction lies in the colour of the vestiture, nevertheless it may be the same as var. *cinera*.

4. NOTOTHIXOS INCANUS Oliv. Plate iv, A.

Journ. Linn. Soc., vii, 1864, 103; Hook., *Ic. Pl.*, i, t. 73, as *Viscum incanum* Hook.; Benth., *B. Fl.*, iii, 397; Mueller, *Fragm.*, ii, 109; Baker, PROC. LINN. SOC. N.S.W., [2], ix, 1894, 158, Plate xi, fig. 1; Bail., *Fl. Q'land*, v, 1382; Engler, Engl. et Prantl., *Pflzfam.*, iii, i, 192, et Nachtr., 139; Moore et Betche, *Handb. Fl. N.S.W.*, 227.

The following is the original description:—"Incano-sericeum, caule ramossissimo, ramis oppositis, foliis spathulatis subcarnos, pedunculis brevi terminali bifloro, floribus foemineis cylindraceis, peranthi limbo 4 lobo."

Densely branched shrubs; union clavate; branches hoary with a minute tomentum, occasionally much compressed below the leaves, the older branches terete, 1-3 feet long; leaves oblong-cuneate or spathulate, narrow into a short petiole, very obtuse, mucronulate, ½-1 inch long, rarely longer, the nerves faint; stipules acute, inconspicuous. Flower heads solitary or sometimes three together, bracteate, on very short terminal quadrangular peduncles, usually with three flowers, the males clavate, about half the size of the females.

When the flowers are ternate the male occupies the central position, and is the first to develop, almost reaching its full size before the two females make their appearance; when fertilization takes place it drops off, leaving the two females, which then convey the impression that the female flowers originate in pairs only. Anthers similar to the other species. Female flowers clavate, fusiform, the petals triangular, concave, persistent. Style conical, stigma obtuse.

Fruit pubescent or scurfy-tomentose, shaded pink, contracted or somewhat stipitate, cylindro-elliptical, crowned with the persistent acute petals, 11 mm. long. Viscin copious; seeds flat, covered with hoary pubescent scales, 5 mm. long, 3 mm. broad. Embryo green, embedded in the dark green endosperm, awl-shaped, embryonic cotyledons acicular. Hypocotyl green, terete, with a few scattered papillae along it, suctoral disc conical, not enlarged. Fruit and seed quite different from those of *N. subaureus*; seeds compressed, 3-4 mm. long, enclosed in a reticulate membrane; hypocotyl terete, the disc scarcely enlarged.

Range.—This species, like all the others, belongs chiefly to the east coast of the continent, and so far has not been found further south than Mt. Kembla, in New South Wales. The following is the extent of its range as at present known:—

Victoria: It is included in Professor A. J. Ewart's Recording Census of the Victorian Flora, 1908, p. 42. I have not seen a Victorian specimen.

New South Wales: Mt. Kembla, on (*Loranthus*) *Phrygilanthus celastroides*, A. G. Hamilton, These PROCEEDINGS, xxxi, 1905, 491; Mudgee, on *Brachychiton* sp.

(always in flower), A. G. Hamilton, ibid, [2], ii, 1887, 282; Port Macquarie, J. H. Maiden; Kendall, on *Melaleuca styphelioides* (Dr. J. B. Cleland); Casino (E. Betche), on *Melaleuca genistifolia* (L. G. Irby); Ballina (R. T. Baker).

Queensland: Brisbane River (F. Mueller), 1855, in Melbourne Herbarium; R. Fraser (the type) quoted by Bentham, l.c., F. M. Bailey and the Rev. J. E. Tenison-Woods, *vide* These PROCEEDINGS, iv, 1879-80, 160; Bulimba, on *Melaleuca genistifolia* (C. T. White and Francis); Burpengary (Dr. T. L. Bancroft); Warrego River (F. M. Bailey); Rockhampton, on *Croton phebalioides* (J. L. Boorman).

Affinity—This species is markedly distinct from its congeners in nearly all essential characters, its nearest affinity appears to be *N. subaureus* Oliv. var. *cinera*, from which it is distinguished by the different vestiture, spathulate leaves, and large urceolate fruits.

Hosts.—Loranthaceae: *Phrygilanthus celastroides* (Sieb.) Eichl.; Euphorbiaceae: *Croton phebalioides* F.v.M.; Sterculiaceae: *Brachychiton* sp.; Myrtaceae: *Melaleuca styphelioides* Cav., *M. genistifolia* Sm., *Angophora* sp., *Eucalyptus* sp.

7. VISCUM Tourn.

Ex *L. Gen.*, ed. i, 1737, 284; Linn., *Spec. Pl.*, ed. i, 1753, 1023; Endl. Gen., n. 4584; Benth., *B. Fl.*, iii, 195; Benth. et Hook. f., *Gen. Pl.*, iii, 213; Engler, Engl. et Prantl, *Pflzfam.*, iii, i, 193, et Nachtr. 139; Bail., *Fl. Q'land*, v, 1381.

Flowers monoecious in the Australian species. Calyx border rudimentary or absent. Corolla in the male flowers somewhat gamopetalous, bi- tri- or tetramerous; petals ovate, cordate or triangular, thick. Anthers forming a somewhat raised mass on the centre of the petals, or sometimes towards the base, without a well-defined division between the numerous pollen-bearing chambers, which are dehiscent by pores. Female flowers of three to four equal deciduous or persistent petals, usually similar to the males. Ovary inferior; style very short, with an enlarged, pulvinate, minutely rugose stigma, which is sometimes enclosed in the fruit, or forming a minute apicula upon it. Fruit ovoid or globose, white, red, or yellowish. Seeds enclosed in a thin white reticulate viscin sac, which breaks down when the seed is ejected from the thin, coriaceous epicarp, and acts as an adhesive for the seed, which is usually compressed, ovate or cordate. Endosperm green; embryos one-three, terete; the suctoral disc rather large for the slender hypocotyl. Embryonic cotyledons hyaline or rudimentary, invariably unequal, and usually withdrawn on germination. Hypocotyl terete, entire (or not cleft).

Leafy or leafless shrubs often parasitic on another member of the same Family. Union ball-like, or clavate without adventitious roots. Branches terete, compressed, or angular, more or less swollen at the nodes; the internodes sometimes striate. Leaves when present simple, opposite and usually well developed, when absent represented by minute stipular-like scales. Flowers axillary or terminal, solitary or fascicled, very small, green or yellowish, often two or three seated within minute cupular, or variously shaped bracts. Fruit baccate, green or yellowish, smooth or verrucose.

There are about 70 species known, mainly indigenous to the warmer parts of the globe. Of the three Australian representatives of the genus, two belong to the aphyllous group.

Sect. PLOIONIXIA (PLOIONUXIA) Korth.

Verh. Batav. Gen., xvii, 1839, 254; Engler, Engl. et Prantl, *Pflzfam.*, Nachtr., 140.

Leaves well developed. Flowers in triads or clustered at the apex of the common peduncle, the central flower of each triad usually staminate.

Leaves well developed ..... 1. *V. Whitei.*

Sect. ASPIDIXIA (ASPIDUXIA) Korth.

Verh. Batav. Gen., xvii, 1839, 258; *Aspidixia* Van Tiegh., *Bull. Soc. bot. France*, xliii, 1896, 191; *Dipleura* Van Tiegh., ibid., 192; Engler, Engl. et Prantl, *Pflzfam.*, Nachtr., 140.

Leaves reduced to microscopic scales. Flowers single or in clusters. Inflorescence androgynous.

Leaves scale-like.

i. Flowers in cymules of three or four flowers. Male buds broadly cordate. Fruit stipitate ..... 2. *V. Bancrofti.*

ii. Flowers solitary or in clusters, usually within a cradle-like bract. Male buds more or less globose. Fruit sessile within the persistent bract .... 3. *V. angulatum.*

1. VISCUM WHITEI, n. sp. Plate vii.

V. orientale Benth. *non* Willd., *B. Fl.*, iii, 1866, 396; Bail., *Q'land Fl.*, v, 1382, as *V. orientale* Willd.; *Comp. Cat. Q'land Pl.*, Fig. 450.

Frutex glaber foliaceus densas pendulus congeries, 1-2 pedes longas proebens; rami tenues; internodia compressa angularia et aliquanto sulata, paulisper ad apicem latiora, 2-4 cm. longa, 2-6 mm. lata. Stipulae lineares acutae 0·5 mm. longae, deciduae. Folia opposita erecta saepe inaequaliter longa angusta-lanceolata, 2-4 cm. longa, 3-8 mm. lata, mucronulata obscure trinervata, in parvum recurvatum petiolum angustata. Flores monoecii cymos sessiles 3-4 florum proebentes, pedunculos subtriangulares bracteatos terminates. Gemmae staminatorum compressae lati cuneatae vel cordatae, dimerae, petalis valvatis persistentibus; antheris triangularibus pluribus poris dehiscentibus. Gemmae pistillatorum cylindracae 2-3 merae, 2 mm. longae; petalis valvatis, triangularibus, deciduis. Fructus globosus, stipitatus 3 mm. diam., seminibus compressus.

Glabrous leafy shrubs forming dense pendulous masses, 1-2 feet long, branches slender, internodes compressed, angular or sulcate, slightly enlarged at the apex, 2-4 cm. long, 2-6 mm. broad, stipules linear, acute, ½ mm. long, soon deciduous. Leaves opposite, erect, often unequal in length, narrow lanceolate, 2-4 cm. long, 3-8 mm. broad, contracted at the top into a very small oblique mucro, obscurely tri-nerved, tapering at the base into a small curved petiole. Flowers monoecious, forming sessile clusters of three or four, terminating compressed or subtriangular, bracteate peduncles, the clusters sometimes all females, but usually only the central flowers male, and the lateral ones female. Bracts persistent, linear, navicular, acute, 2-3 mm. long. Male buds compressed, broad cuneate, cordate or obtuse, bi-merous; petals valvate, concave, persistent on the receptacle; anthers triangular, five- to seven-celled. Female flowers cylindrical, acute, bi- or tri-merous, 2 mm. long; petals valvate, triangular, soon deciduous; style small; stigma scarcely enlarged (the flowers are similar to those of *V. Bancrofti* in every detail). Fruit shortly stipitate, globose, striate, 3 mm. in diameter, the persistent stigma apiculate; seeds compressed.

Range.—Berserker Range, Rockhampton, Queensland, in Melbourne Herbarium, labelled *Viscum orientale* Willd. (This is probably the specimen quoted by Bentham thus: "Rockhampton, Bowman: a single small specimen in (Herb.) F. Mueller".); Stannary Hills (Dr. T. L. Bancroft, 1909, the type). It is also recorded in *Queensland Naturalist*, i, 1911, p. 207, as *V. orientale* Willd.

Affinity.—It is allied to *V. Bancrofti* in general characters, except that it is leafy and the fruits are striate or banded. Its affinity with *V. orientale* Willd., lies chiefly in its leafy character, and in the smooth fruits, while there is an uncertainty about the male flowers being the same, as I have not seen a description of the male flowers of *V. orientale* Willd.

Named in honour of C. T. White, Government Botanist, Queensland.

2. Viscum Bancrofti, n. sp. Plate viii.

Frutex parasiticus sine foliis, complenus elevatus; rami penduli longi tenues angustri orl adultiores terete; internodis 3-5 cm. longis, 1-4 mm. latis; stipulae triangulares 0·5 mm. longae.

Flores monoecii, di- orl tri-meri; bracteis carentes, plerumque triades in apice pedunculi, 3-7 mm. longi; internodiis similis, orl forsitan cymulum 5 florum probentes; gemmae florum staminatorum deimerae, 2·5 mm. longae, congeries, cordatae; petalis cordatae concavae; staminalis aliquanto magno, triangularis, pluri poris dehiscens. Gemmae florum, cylindricae 2-3 mm. longae; petali triangularis, concavi, acuti, 0·5 mm. longi, decidui. Fructus globosus translucens, stipitatus 3-4 mm. diam.

Leafless parasitic shrubs; union clavate; branches pendulous long and slender, usually very numerous, angular or the old ones terete, 1-2 feet long or more; internodes 3-5 cm. long, 1-4 mm. broad, compressed, angular or terete, and often finely striate, expanded at the top into a dilated acute stipular-like socket, stipules triangular, acute, ½ mm. long. Flowers monoecious, di- or trimerous with small floral bracts, usually in triads on the apex of a common peduncle, 3-7 mm. long, similar to the internodes, or sometimes five flowers in a cymule, or a few solitary ones scattered along the branches, particularly on the nodes of the old branches, and also at the base of the cymule. Male buds dimerous, 2½ mm. long, usually developing before the females, compressed, cordate, with a cuneate base, which is raised on a minute common peduncle, the basal portion or receptacle sometimes thickened on one side into a lobe-like projection, while on the other side it is truncate, and usually shorter than the persistent petals, which are cordate, concave and rather thick with very thin edges, 1-3 mm. long and about as broad. Staminal mass comparatively large, triangular dehiscent by seven to ten or more pores. Female buds di- or trimerous, usually the former, cylindrical, acute, 2-3 mm. long; petals triangular, concave, acute ½ mm. long, very early deciduous. Style thick, ½ mm. long, stigma domed. Fruit globose, yellowish, semi-transparent, apiculate, with the persistent and slightly enlarged style, shortly stipitate, 3-4 mm. in diameter; epicarp thin; viscin copious and very elastic; seed compressed, roundish or somewhat obcordate, 2½ mm. long, endosperm green, hypocotyl terete, very slender, sometimes exceeding 7 mm. before attachment takes place; suctoral disc rather large, microscopically papillose; embryo cotyledons acicular, very thin, ¼ mm. long.

Range.—Eidsvold, Queensland, parasitic on *Loranthus Quandang*, var. *Bancrofti*, the Loranth parasitic on *Acacia harpophylla*. Dr. T. L. Bancroft, No. 11, 1918. The type. Dr. Bancroft writes: "This Viscum roots on the *Loranthus*, never on the 'Brigalow' *Acacia harpophylla*. It is killed by frosts, whereas the Loranth is not affected. It is always in flower and fruit. This Viscum appears to have been dioecious at one time, but now the male flowers are not produced, or only rarely. The fruit is not produced parthenogenetically".

Named in honour of the distinguished collector Dr. T. L. Bancroft, who has rendered valuable service to botany in the discovery of many new plants.

Affinities.—It is closely allied to *V. Whitei*, from which it differs in being leafless, even very young plants failing to show the slightest trace of leaves. It is allied to *V. angulatum* in the virgate branches only; all the other characters are totally different. It does not appear to have any close affinities among other leafless species.

3. Viscum angulatum (Heyne, Herb.) ex DC. Plate ix.

DC. Prod., iv, 1830, 283; G. Don., *Gen. Hist.*, iii, 407; Wight et Arn., *Prod.*, iii, 396; Daly and Gibs., *Bomb. Fl.*, 110; Miq., *Fl. Brit. Bat.*, i, pt. i, 806; F.v.M., *Rept. Burd. Exped.*; Hook., *Fl. Brit. Ind.*, v, 226; Moore and Betche, *Fl. N.S.W.*, 227; Bail., *Fl. Q'land*, v, 1384; Bail., *Comp. Cat. Q'land Pl.*, Fig. 451, p. 466.

The following is the original description:—

"Aphyllum, ramis, angulatus 4 gonis articulatus, floribus . . . in India orientali legit c.l. Heyne. Species exspecim imperf. distinctissima, sed vix nota. . . ".

It will be seen that the species was named on very imperfect material, as the flowers and fruits were unknown. Having no definite characters to work out the Australian material, I critically examined and compared the Australian plant with the following specimens, from which it differs unessentially.

1. *Viscum angulatum* Heyne, on *Loranthus* sp., Botanic Gardens, Singapore, C. F. Baker, Oct., 1917, Ex. Herb. C. F. Baker, determined by E. D. Merrill.

2. There is also another specimen from the same locality, labelled *V. articulatum* Brown, 1899, without collector's name, etc. It was received from the same source some years previously and is identical with the above.

3. *V. angulatum* Heyne. (*V. capense* Blume *non* L. F.); Merrill's species, Blancoanal, No. 695, determined by E. D. Merrill. This specimen appears not to differ from the rest of the Australian specimens except in the shortness of the internodes, which are uniformly short throughout, and shorter than the Australian specimens.

The following description of the Australian plant is drawn up from L. G. Irby's No. 959, from Casino.

Leafless parasitic shrubs forming pendulous masses 1-3 feet long, 1-2 feet in diameter; union fusiform; branches angular or the older one terete; internodes 2-7 cm. long, 2-5 mm. broad, at first compressed, eventually becoming tri- or quadrangular, the expanded floral receptacle scarcely acute, and only slightly exserted. Flowers minute, solitary or in pairs on the young branches, whorled or in small clusters or three or four on the older ones. Bracts when the flowers are solitary two, the lower one triangular, ciliate, the upper or floral one, cradle-shaped, ciliate, ½ mm. deep, longer than broad, enlarging somewhat under the fruit. Male buds globose, conical or subcylindrical, obtuse or acute, 1¼ mm. long, usually sessile at the base of the females or sometimes geminate in the cradle-like bract, tri- or tetramerous; petals persistent on the fertile flowers, deciduous on the barren ones; when trimerous cordate, 1 mm. long and nearly as broad; when tetramerous triangular, but usually only two of the broadest petals staminate. Anthers forming a convex mass on the inner surface of the petal, dehiscent by five to eight pores. Female buds cylindrical 1½-1¾ mm. long, single or geminate within a cradle-like, ciliate bract, tri- or tetramerous, but usually the former; petals triangular, about ½ mm. long, deciduous, paler than the ovary; stigma very

small, obtuse. Fruit globose, yellowish, but not seen in a fresh state (according to Mueller, purplish-white, the size of a small pea), 3-4 mm. in diameter, crowned with the small persistent stigma, and articulate below the bract, so that in most cases the ripe fruit falls with the bract attached to it, but at the same time it is separable from the bract, and a small rudimentary pedicel or stipes is then observed. Seeds cordate or obtusely triangular, about 1 mm. long, and as broad, covered with a white reticulate membrane which acts as an adhesive; endosperm green; embryo terete, curved; cotyledons acute; hypocotyl slender, attenuated to 3-5 mm. on germination; disc rather large and minutely papillose under the lens. It is not known whether the cotyledons are withdrawn or remain in the endosperm after germination.

Synonyms.—*Viscum psilitoides* A. Cunn. (Herb.), No. 101, 1828; *V. capense* Blume (*non* L.F., according to E. D. Merrill).

Range.—This species appears to confine itself to the coast, and like all other members of the family its progress seems to be in a southerly direction, as it is far more plentiful in the northern parts of the continent than in the south. Its most southern limit is Ramornie, near Copmanhurst, N.S.W.

South Australia: R. Schornberg, Flora of South Australia, p. 43, records it for South Australia. I have not seen a specimen from that State. His reference probably refers to the Northern Territory, which at one time formed part of South Australia.

New South Wales: Ballina; Casino on *Casuarina torulosa*; Ramornie, on *Loranthus vitellinus* and *Notothixos subaureus* (W.F.B. and D.W.C.S.).

Queensland: Bremer River, Moreton Bay, A. Cunningham, No. 101, July, 1828 (*V. psilitoides* A. Cunn.) in Queensland Herb.; Brisbane River, on Native Cherry, *Exocarpus* sp.; Ithaca Creek, on *Loranthus vitellinus*; Maryborough District, on *Loranthus* sp.; Mount Perry, J. Keys, *Proc. Roy. Soc. Q'land*, ii, 1895, 49; Port Denison, W. Hill. Quoted by Bentham; Edgecomb Bay, Dallachy, quoted by Bentham; Townsville, on *Loranthus vitellinus*; Cardwell, Rockingham Bay, "Found growing and suspended from a *Loranthus*, also alive on a wattle tree, *Acacia* sp., in the forest and not in the real shrub". S. W. Jackson; Dunk Island, on lemon tree; Herberton; Stannary Hills; Gilbert River, F. Mueller, quoted by Bentham; sources of the South Coen River; Gulf of Carpentaria; F. Mueller, *Append. Land. Exped. Aust.*, 116; vide also *Roy. Soc. S.A.*, 1895; Ewart and Davies, *Fl. N.T.*, 89; Prince of Wales Island. It is also common in Papua.

Affinity.—Amongst the Australian species it is nearest to *V. Bancrofti* in general appearance, but it is totally different in the male flowers and mode of flowering.

Hosts.—Casuarinaceae: *Casuarina torulosa* Ait.; Loranthaceae: *Loranthus vitellinus* F.v.M., *Notothixos subaureus* Oliv.; Rutaceae: Lisbon lemon; Santalaceae: *Exocarpus* sp.; Leguminosae: *Acacia* sp.

EXPLANATION OF PLATES I-IX.

Plate i.

Korthalsella articulata (Benth.) Blakely.

1. Plant, four-fifths natural size; *a*, showing union with the host.—2. A minute young tip greatly enlarged to show the ciliate border on the immature internodes.—3. Two internodes enlarged; *a*, showing male and female buds, and fruits; *b*, showing the floral cushion.—4. Types of young male buds.—5. A male flower greatly enlarged.—6. A male flower with the front petal bent down to show the connate anthers, also the moniliform cilia.—7. Camera lucida drawing by Miss M. Flockton of a male flower, showing the anthers artificially opened.—8. Male flower of *Pseudixus japonica* Hayata

(after Hayata).—9. A female flower with the moniliform cilia at base.—10. Top of female flower showing the stigma.—11. Fruit.—12. Germinating seed, four-fifths natural size.—13. Embryo.—14. Germinating seed with the membranous viscin sac raised around it, and the pointed hypocotyl.—15. Germinating seed separated from the host after attachment took place, to show the broad disc.—16. A young plant taken from the host, having lost the endosperm.—17. A young plant, four-fifths natural size.—18. A plant, four-fifths natural size, with rather large floral cushions and numerous flowers

All variously enlarged, except where indicated.

Plate ii.

A. Korthalsella australis (Bail.) Blakely.

1. A plant, four-fifths natural size.—2. Male bud.—3. Male flower opened out to show the connate anthers.—4. Male flower with the petals removed.—5. Female flower surrounded by moniliform cilia.—6. Fruit.—7. Longitudinal section of seed showing the germinating embryo.

B. *Korthalsella Howensis* (Van Tiegh.) Engler.

8. Plant, four-fifths natural size.—9. A very young turbinate male flower.—10. A clavate male bud with a tuft of cilia at base.—11. Front view of a male flower.—12. Back view of a male flower.—13. Fruit.—14. Germinating seed.—15. Embryo.

All enlarged, except where indicated.

Plate iii.

Korthalsella opuntioides (Bauer) Blakely.

1. Basal portion of a plant, four-fifths natural size.—2. Terminal portion of one of the branches of Fig. 1.—3. Male bud.—4. Female flower.—5. Fruit.—6. Seed.—7. Longitudinal section of an internode.—8. Cross section of Fig. 7.—9. Portion of a young plant showing the union and variation in the internodes.—10, 11. A large internode, four-fifths natural size, showing both surfaces.—12, 13. A form with very narrow internodes, four-fifths natural size, probably referable to *K. bigibba* (Van Tiegh.) Engler.

All greatly enlarged, except where indicated.

Plate iv.

A. *Notothixos incanus* Oliv.

1. Flowering branch, four-fifths natural size.—2. Cymule of very young buds.—3. An advanced cymule, showing the two female buds and the male bud in the centre.—4. Female flower.—5. Seed, four-fifths natural size.—6. Seed enclosed in the reticulate sac.—7. A germinating seed.—8. Female flower, one of the segments of the calycine limb being removed.—9. Fruit (scarcely mature).—10. Vertical section of fruit (8, 9, 10 after Hooker).

B. *Notothixos cornifolius* Oliv.

11. Flowering and fruiting branch, four-fifths natural size.—12. Terminal portion of a flowering branch, four-fifths natural size.—13. An acuminate leaf, four-fifths natural size.—14. A cymule of male flowers.—15. Female flower.—16. Male flower opened out to show the anthers (after Baker).—17. Ground plan of female flower (after Baker).—18. Back view of anther.—19. Front view of anther.—20. Seed, four-fifths natural size.—21. Seed without the membranous sac.—22. Seed with the membranous sac.

All greatly enlarged, except where indicated.

Plate v.

Notothixos leiophyllus K. Sch.

1. A branch showing the inflorescence, four-fifths natural size.—2. A leaf, four-fifths natural size.—3. Portion of a branch, to show the acuminate bracts.—4, 5. Types of female flowers.—6. A male flower.—7. A male flower opened out to show the anthers and the broad disc.—8. A fully expanded anther.—9. Vestiture.

All greatly enlarged, except where indicated.

Plate vi.

Notothixos subaureus Oliv.

1. Portion of a flowering and fruiting branch, four-fifths natural size.—2. N. Base of a young plant showing the union with the host. P.P. *Phrygilanthus eucalyptifolius*, four-fifths natural size.—3. A cymule of female and male flowers.—4. Cymule with the

flowers removed to show the deep notches.—5, 6. Types of female buds.—7, 8. Types of male buds.—9. Female flower.—10. Male flower.—11. A petal and a fully expanded anther.—12. Front view of anther.—13. Side view of anther.—14. Two pollen grains.—15. Fruit, four-fifths natural size.—16. Seed, four-fifths natural size.—17. Longitudinal section of seed to show the embryo.—18. A germinating embryo removed from the seed.—19. Germinating seed.—20. A very young plant, four-fifths natural size, showing the union with the host, two stipular-like bracts, and the two first leaves.

All greatly enlarged, except where indicated.

Plate vii.

Viscum Whitei, n. sp.

1, 2. Portion of a branch, four-fifths natural size.—3. Enlarged cymule of male and female flowers.—4. A female flower, enlarged.—5. Fruiting cymule, enlarged.

Plate viii.

Viscum Bancrofti, n. sp.

1. A young flowering and fruiting plant, four-fifths natural size.—2. Cymule of male and female flowers.—3. A cymule of female flowers showing the unequal development.—4. Male flower with the petals.—5. A remarkable form of proliferation of two female flowers.—6. One of the petals of the lower female flower of 5.—7. A trimerous female flower.—8. A bimerous female flower.—9. A male flower.—10. Male flower opened out.—10*a*. Petal showing the irregular anther.—11. A young male bud showing the reverse side of calyx to that of Fig. 2.—12. A fruiting cymule.—13. Fruit, four-fifths natural size.—14. Seed, four-fifths natural size.—15. A germinating seed with a very elongated hypocotyl.—16. A young plant showing the suctoral disc and cotyledons.—17. A very young plant, four-fifths natural size.

All greatly enlarged, except where indicated.

Plate ix.

Viscum angulatum Heyne.

1. Portion of a branch showing the flowers and fruits, four-fifths natural size.—2. Portion of a branch showing two female buds.—3. Branch showing two female and two male buds.—4. Two male buds within the cradle-like bract, showing the unequal size.—5. A male bud from the base of a female bud as in Fig. 3.—6. A trimerous male flower opened out to show the connate anthers.—7. A pair of female buds about half developed.—8. A terminal female bud about half developed.—9. A solitary female bud within the bract.—10. A very young bud showing the cradle-like bract in the early stages.—11. A trimerous female flower.—12. A tetramerous female flower.—13. Fruit.—14. Seed, about four-fifths natural size.—15. Seed enlarged.—16. A young hypocotyl enlarged to show the suctoral disc and the cotyledons.—17. A petal to show the connate anthers.

All greatly enlarged, except where indicated.

CRANE-FLIES (TIPULIDAE, DIPTERA) FROM BARRINGTON TOPS, NEW SOUTH WALES.

By Charles P. Alexander, F.E.S., Amherst, Massachusetts, U.S.A.[1]
(Communicated by I. M. Mackerras, M.B., Ch.M., B.Sc.)

[Read 27th April, 1928.]

The crane-flies collected by the members of the Sydney University Zoological Expedition to the Barrington Tops, New South Wales, have been sent to me by Dr. I. M. Mackerras for examination and report. Very few specimens of Tipulidae have been previously taken on the Barrington Tops, and our knowledge of these flies from the higher altitudes of northern New South Wales is still extremely limited. It is for this reason, chiefly, that the percentage of undescribed species in the present series is unusually high, including nearly one-half of the total number taken.

The collections considered herein were taken mostly at an elevation of approximately 5,000 feet during January, 1925. All types and uniques have been returned to Dr. Mackerras and will be deposited in the Macleay Collections in the University of Sydney. My sincere thanks are extended to Dr. Mackerras and others of the Expedition who aided in the collection of material for the privilege of studying this very interesting series of Australian Tipulidae.

The total number of Tipulidae taken on the Tops is approximately 50, but there are a few species, chiefly in the involved genus *Molophilus*, that are represented only by females and which cannot be finally determined on this material.

The complete list of species in the collection is as follows:

Plusiomyia (*Plusiomyia*) *mackerrasi*, n. sp.
Acracantha sydneyensis Skuse
Ischnotoma serricornis (Macquart)
I. par (Walker)
I. rubriventris (Macquart).
I. subabnormalis, n. sp.
Phymatopsis periploca, n. sp.
P. intricata, n. sp.
Habromastix similior Alexander
Macromastix costalis (Swederus)
M. aurantioceps subnitida Alexander
Dolichopeza annulipes oresitropha, n. subsp.
D. longidigitalis Alexander
Geranomyia (*Triphana*) *tenebricosa* Alexander
G. (*T.*) *risibilis*, n. sp.
Dicranomyia punctipennis Skuse
D. saxatilis Skuse
D. obscura Skuse
D. ochrirostris Alexander
Limonia obscuripennis (Skuse)
L. zonata (Skuse)
Discobola australis (Skuse)
Orimargula australiensis Alexander
Austrolimnophila munifica, n. sp.
Limnophila edita, n. sp.
Gynoplistia (*Paralimnophila*) *fuscodorsata*, n. sp.
G. (*P.*) *remulsa*, n. sp.
G. (*P.*) *harrisoni*, n. sp.
G. (*P.*) *barringtonia*, n. sp.
G. (*P.*) *mystica*, n. sp.
G. (*Gynoplistia*) *flavofemorata*, n. sp.
G. (*G.*) *westwoodi opima*, n. subsp.
G. (*G.*) *nicholsoni*, n. sp.
G. (*G.*) *cultrata*, n. sp.
G. (*G.*) *bimaculata nigrotibialis* Alexander
G. (*G.*) *obscurivena* Skuse
G. (*G.*) *histrionica*, n. sp.
G. (*G.*) *viridis helmsi* Alexander
G. (*G.*) *pammelas*, n. sp.
Elephantomyia tasmaniensis barringtonia Alexander
Tasiocera barringtonensis, n. sp.
Molophilus froggatti Skuse
M. macleayanus, n. sp.
M. flavocingulatus, n. sp.
M. pulchripes Skuse

[1] Contribution from the Department of Entomology, Massachusetts Agricultural College.

Descriptions of New Species and Subspecies.

PLUSIOMYIA (PLUSIOMYIA) MACKERRASI, n. sp.

General coloration grey, the prescutum with four brown stripes; pleura silvery-grey with two brown longitudinal stripes; wings brown with a whitish pattern that includes a nearly complete, narrow crossband beyond the cord, extending from costa into cell M_4.

♂. Length about 26 mm.; wing, 22-24 mm. ♀. Length 33-34 mm.; wing, 22·5-23 mm.

Frontal prolongation of the head elongate, dark fulvous, the nasus stout; palpi black. Antennae brownish-black, the four simple terminal segments sometimes a little paler; first flagellar segment with a stout subapical protuberance; flagellar segments two to seven each with a pair of basal appendages that are approximately as long as the segments; in some, the eighth flagellar segment bears a single weak basal protuberance. Head grey, the centre of the vertex more infuscated.

Pronotum fulvous-brown, silvery laterally. Lateral pretergites dark brown. Mesonotal prescutum grey with four brown stripes, the intermediate pair separated only by a dark reddish-brown median vitta; lateral margin of the sclerite dark brown; pseudosutural foveae small, black; scutum light grey, the lobes almost covered by dark brown areas; remainder of the mesonotum light grey, the central portion of the scutum, the scutellum and a broad median line on the postnotal mediotergite brown. Pleura silvery grey pruinose, with two narrow, longitudinal, brown stripes, the more dorsal extending from the cervical region across the ventral propleura on to the anepisternum and pteropleurite; the ventral stripe includes the ventral sternopleurite and meron. Halteres brown, the knobs darker. Legs with the coxae silvery grey; trochanters obscure yellow, the apex brown; femora yellowish-brown to brown, the bases narrowly clearer yellow, the tips brownish-black; tibiae dark brown, the tips still darker; tarsi black. Wings pale brown, with a handsome whitish pattern, distributed as follows: A spot in cell R, before the origin of Rs, confluent with a large area in the outer half of cell M; a broad, oblique crossband beyond the cord, including the bases of cells R_2, R_3 and R_5, almost all of cell 1st M_2, the extreme outer end of cell R and the basal portions of cells M_3 and M_4; bases of cells Cu, 1st A and 2nd A conspicuously pale; remainder of cubital and anal cells greyish-brown; outer medial cells paler than the general dark colour of the wing; veins dark brown. Venation: Cell M_1 sessile.

Abdomen with the basal tergite pruinose, brown medially; second tergite light fawn-brown, sparsely pruinose, the median line dark brown; tergites three and four grey, with a dark brown median line, the basal ring a little brighter laterally; a dark brown lateral stripe on tergites one to three; tergites five to seven dark grey, with a brown median line that becomes obsolete on the seventh segment; hypopygium dark; sternites pale reddish-brown, darker medially, the outer segments darker. In some specimens, the abdomen is uniform grey and brown, without the brighter basal coloration. In the female, the bright coloration of the basal rings of the tergites includes segments two to seven.

Holotype, ♂, Barrington Tops, January, 1925 (S.U. Zool. Exp.). Allotopotype, ♀. Paratopotypes, 2 ♂, 1 ♀.

This interesting species is named in honour of Dr. Ian Mackerras, to whom I would express my deep indebtedness for many kind favours in the past. *Plusiomyia mackerrasi* somewhat resembles a small specimen of *P. olliffi* Skuse in the general pattern of the wing, but differs conspicuously in the broader wings

with a narrower and more oblique white crossband beyond the cord, together with the whitened centre of the small cell M_4.

ISCHNOTOMA SUBABNORMALIS, n. sp.

General coloration grey; mesonotal prescutum with four brown stripes; wings greyish, the veins beyond the cord vaguely seamed with pale brown; basal abdominal segments reddish-brown, the subterminal segments darkened.

♂. Length about 13 mm.; wing, 13·5 mm. ♀. Length, 17-18 mm.; wing, 16-17 mm.

Frontal prolongation of head reddish-brown, darker above, including the long nasus; palpi brownish-black. Antennae with the basal segment of the scape buffy-yellow, the second segment reddish-brown; flagellum black. Head brown, the orbits and genae light grey.

Mesonotal prescutum clear grey to yellowish-grey laterally, with four entire brown stripes, the interspaces more greyish, especially near the suture; scutum dark brown, the posterior angles of the lobes a little brightened; scutellum brownish-black, the parascutella grey; postnotum grey with a dusky median triangle, the point directed backward. Pleura light grey, variegated with darker grey to form two vague longitudinal stripes, the more dorsal including the propleura and anepisternum, the ventral stripe occupying the ventral sternopleurite; dorso-pleural region infuscated, restrictedly sulphur-yellow near the anterior spiracle. Halteres dark brown, the base of the stem restrictedly paler. Legs with the coxae light grey; trochanters light brown; femora yellow, the apices broadly brownish-black; in the type male this darkening includes the distal third or more, in other specimens the darkened tips narrower; tibiae brown, the tips darker; tarsi dark brown. Wings greyish; stigma pale yellowish-brown, the caudal portion darker; veins beyond the level of the origin of Rs vaguely seamed with pale brown; veins dark brown. Venation: R_3 evenly and gently arcuated for its entire length, diverging from R_{4+5}.

Basal abdominal tergite dark brown; tergites two to four reddish-brown, extensively darkened medially; subterminal segments more uniformly darkened; hypopygium obscure yellow; basal sternites uniformly reddish-brown. Male hypopygium with the ninth tergite having the lateral lobes very broad, obliquely truncated. Outer dististyle flattened, the apex with a conspicuous rounded notch, the two apical points nearly equal in size, obtuse at their tips; a small basal lobe on the style, this provided with one or two apical spines. Armature of the inner dististyle relatively sparse.

Holotype, ♂, Barrington Tops, January, 1925 (S.U. Zool. Exp.). Allotopotype, ♀. Paratopotypes, 4 ♀.

Ischnotoma subabnormalis is very closely related to *I. abnormalis* (Alexander) and *I. immaculipennis* Alexander. It differs from *abnormalis* especially in the details of structure of the male hypopygium. *I. immaculipennis* is still known only from females. It differs from the present species in the unmarked wings, with Rs more angulated, and R_3 more extended on its distal half, not arcuated to the margin.

PHYMATOPSIS PERIPLOCA, n. sp.

General coloration obscure yellow, the prescutum with four nearly confluent brown stripes; wings creamy, with an intricate more or less angularly crossbanded brown pattern; anterior cord narrowly margined with creamy; Rs a little

longer than R_{2+3}; abdominal tergites buffy-brown, the caudal margins of the segments conspicuously blackened.

♂. Length about 7 mm.; wing, 8·5-8·6 mm.

Frontal prolongation of the head obscure brownish-yellow, without a nasus; palpi brownish-black. Antennae short, if bent backward not extending far beyond the pronotum; scapal segments testaceous, the flagellum dark brown; basal flagellar segment conspicuously larger than the others. Head brown, the posterior orbits a little paler.

Pronotum testaceous above, dark brown laterally. Mesonotum obscure yellow with four nearly confluent dark brown stripes; scutum similarly dark brown, paler in the vicinity of the suture; remainder of mesonotum rather dark testaceous brown, the base of the postnotal mediotergite brighter; posterior area of the pleurotergite conspicuously blackened. Remainder of the pleura yellowish pollinose, with two vague brownish areas, the more dorsal occupying the ventral anepisternum, the lower stripe occupying the ventral sternopleurite. Halteres obscure yellow, the knobs dark brown. Legs with the coxae brownish-yellow, the posterior coxae clearer yellow; trochanters yellow; femora brownish-testaceous, the tips narrowly blackened; tibiae brown, the tips narrowly blackened; tarsi black. Wings with a creamy ground colour, handsomely variegated with pale brown, the stigma darker brown; the brown clouds are distributed more or less in the form of crossbands, as follows: A relatively extensive mark immediately beyond the arculus, including the bases of cells C, R, M and Cu_1; an irregular band before the origin of Rs, extending to vein Cu; a smaller dark cloud at origin of Rs, connected with a narrow irregular fascia that crosses cells R and M immediately before the cord; fork of Rs and anterior cord narrowly bordered by creamy; a brown fascia beyond the cord includes the base of cell R_5 and most of cell 1st M_2; a broad band on the posterior cord; wing-tip broadly darkened; cells Cu_1 and anal cells infumed except near the base of cell 1st A; veins dark brown, paler in the creamy areas. Venation: Rs a little longer than R_{2+3}; R_2 relatively long, subequal to or longer than r-m; cell M_1 narrowly sessile to short-petiolate; cell 2nd A narrow.

Abdominal tergites buffy-brown, the caudal margins of the tergites blackened, more conspicuously so on segments two to four, narrower on segments five and six; a subterminal blackish ring; sternites more uniformly pale brown, the caudal margins of the segments weakly infuscated.

Holotype, ♂, Barrington Tops, January, 1925 (S.U. Zool Exp.). Paratopotype, ♂.

Phymatopsis intricata, n. sp.

♂. Length about 9 mm.; wing, 11·3 mm.

Generally similar to *P. periploca*, n. sp., differing as follows: Size larger, as shown by the measurements. Head with the orbits and genae conspicuously paler than the vertex. Posterior pleurotergite darker than the anterior portions but scarcely blackened. Wings much as in *periploca* but the pattern even more intricate; cells R and M cream-coloured, the basal darkening very restricted; the second dark band is angularly bent, in cell M lying more distad than in cell R; Rs is surrounded by a semicircular dark marking, the extreme centre adjoining the veins being pale; an extensive dark cloud occupies cell R_1 before the stigma and along the cord, interrupted by cream-coloured spots at the fork of Rs and near the fork of M; the extensive cream-coloured crossband beyond the cord is inter-

rupted at vein M_{1+2}, in the median field being broken into creamy spots in the bases of cells M_1 to M_4. Venation: Rs unusually long, more than one-third longer than R_{2+3}; r-m greatly reduced; cell M_1 very short-petiolate to nearly sessile.

Abdominal tergites conspicuously banded with black.

Holotype, ♂, Barrington Tops, January, 1925 (S.U. Zool. Exp.).

The four small species of *Phymatopsis* in Eastern Australia may be separated as follows:

1. Wings unmarked except for the stigma (N. Queensland) .... *brevipalpis* Alexander
   Wings cream-coloured, cross-banded with pale brown 2
2. Rs short, about two-thirds R_{2+3}; cells R and M evenly cross-banded with brown (New South Wales) ..... *brevirostrata* Alexander
   Rs as long as or longer than R_{2+3}; cells R and M irregularly cross-banded with brown 3
3. Size large (wing, ♂, more than 10 mm.); Rs fully one-third longer than R_{2+3}; base of Rs with a large dark cloud with a small pale centre (New South Wales) ..... *intricata*, n. sp.
   Size small (wing, ♂, less than 9 mm.); Rs subequal to or only a little longer than R_{2+3}; base of Rs with a small dark cloud (New South Wales) .... *periploca*, n. sp.

Dolichopeza annulipes oresitropha, n. subsp.

♂. Length about 11 mm.; wing, 12 mm. ♀. Length, 11-15 mm.; wing, 11·5-14 mm.

Allied to *annulipes* Skuse, differing in the following regards:

Rostrum brownish with a brown median line. Anterior vertex bright yellow. The oblique pleural stripe is bright sulphur-yellow on the humeral region of the prescutum, the lateral pretergites and the dorsopleural region, on the remainder of the pleura (anepisternum, posterior sternopleurite, pteropleurite and metapleura) pale in colour, but dull, the surface sparsely pruinose. Halteres dark brown, the base of the stem brighter; in a few examples, the halteres are yellow with only the knobs dark brown. Legs with the terminal tarsal segments a little darkened; fore and middle coxae chiefly blackened; the amount of white on the tibial apices is least on the mid-tibiae. Wings with the ground-colour very dark, with three cream-coloured areas, before and beyond the stigma and near the fork of M; stigma and cell Sc darker than the remainder of the wing; most of the veins further seamed with brown. Anal angle of the wing slightly prominent. Venation: m-cu approximately its own length before the fork of M. Abdominal tergites dark brown, each of segments two to five with a conspicuous yellowish triangle on either side, lying between the uniformly darkened basal ring and the dark median triangle that occupies the caudal end of each segment; on tergites six to eight the pale coloration is restricted to a spot on either side; sternites dark, the caudal margins of the segments pale, widest on segment seven; hypopygium chiefly pale.

The dark brown posterior vertex and occiput contrast conspicuously with the bright yellow-anterior vertex, the point of union being somewhat darker brownish-black and more shiny. Frontal prolongation of the head pale greyish-brown, the brown median line conspicuous. Pronotum with the scutellum brownish-black, extending to the concolorous coxae. The entire disk of the prescutum is blackened, the humeral triangles remaining bright yellow; interspaces slightly more velvety-black than the stripes.

Holotype, ♂, Barrington Tops, January, 1925 (S.U. Zool. Exp.). Allotopotype, ♀. Paratopotypes, 12 ♂, ♀.

GERANOMYIA (TRIPHANA) RISIBILIS, n. sp.

General coloration brownish-yellow, the prescutum with three black stripes; femora obscure yellow, all with a relatively narrow brownish-black subterminal ring; wings brownish-yellow, with a relatively sparse brown pattern; male hypopygium with the rostral prolongation of the ventral dististyle short and broad.

♂. Length (excluding rostrum) about 8-8·5 mm.; wing, 7·8-8·5 mm.; rostrum, 1·7-1·9 mm. ♀. Length (excluding rostrum) about 10 mm.; wing, 9 mm.; rostrum, 2·1-2·2 mm.

Rostrum and palpi black; rostrum short, if bent backward not extending far beyond the wing-root. Antennae brownish-black throughout. Head velvety-black, with a capillary silvery-grey median vitta.

Pronotum dark brown, the sides brownish-yellow. Mesonotum brownish-yellow, the humeral region of the prescutum clearer yellow; three clearly defined black stripes, the median stripe not reaching the suture, the lateral stripes crossing the suture and suffusing the scutal lobes; median region of scutum pale, sparsely pruinose; scutellum brownish-yellow, in some cases dark brown; postnotum dark brown medially, paler laterally, the surface vaguely pruinose. In some specimens, the lateral prescutal stripes are less distinct. Pleura obscure yellow, the anepisternum and pleurotergite more infuscated; dorsopleural region dusky. Halteres yellow, the knobs brown. Legs with the coxae obscure brownish-yellow; trochanters testaceous yellow; femora obscure yellow with a relatively narrow brownish-black subterminal ring on all the legs, a little narrow on the middle femora; tibiae light brown, the tips darker brown; tarsi dark brown. Wings brownish-yellow with a relatively sparse but conspicuous brown pattern, distributed as follows: A rectangular area at origin of Rs, including cells Sc and R, cell C being less evidently darkened; an oval spot on Sc_2; stigma oval, connected with a large circular spot at the fork of Rs; narrow brown seams along the cord and outer end of cell 1st M_2; wing-tip narrowly but evidently darkened; a pale brown cloud in outer end of cell 1st A; veins brown, darker in the infuscated areas. Venation: Sc long, Sc_1 ending near two-thirds the length of the long Rs, Sc_2 from two to three times its length from the tip; R_2 about twice the free tip of Sc_2 beyond it; m-cu varying from about one-third to one-fifth its length before the fork of M.

Abdominal tergites dark brown; basal sternites brown, a little darker basally, the outer sternites more uniformly darkened. Male hypopygium as in *annulata*, differing especially in the short and broad rostral prolongation of the ventral dististyle, with the spines placed close to the base, and the longer and more slender apical lobes of the gonapophyses.

Holotype, ♂, Barrington Tops, January, 1925 (S.U. Zool. Exp.). Allotopotype, ♀. Paratopotypes, 4 ♂, ♀.

Geranomyia risibilis is most closely related to *G.* (*T.*) *annulata* Skuse, differing especially in the uniform nature of the subterminal brown annuli of the femora and in the details of structure of the male hypopygium.

AUSTROLIMNOPHILA MUNIFICA, n. sp.

General coloration dark brown, the prescutal stripes more reddish-brown; femora chiefly brownish-black with a narrow subterminal yellow ring; wings yellow with a heavy solid brown pattern, including a crossband at the cord and conspicuous seams to the veins; R_{2+3+4} longer than m-cu, the latter placed at mid-length of cell 1st M_2.

♀. Length about 13 mm.; wing, 13 mm.

Rostrum brown; palpi black. Antennae (♀) relatively long for this sex, if bent backward extending to the base of the abdomen; scapal segments dark brown; basal two or three flagellar segments dark brown, their apices yellow, the amount decreasing on the outer segments; following flagellar segments uniformly dark brown; flagellar segments long-cylindrical, with relatively long verticils. Head dark brown medially, the anterior vertex and orbits a little brighter.

Pronotum brownish-black. Mesonotal prescutum brownish-black, the usual stripes more reddish-brown, virtually confluent; median region of scutum and the scutellum obscure yellow, the scutal lobes and parascutella darker; postnotal mediotergite pale brown. Pleura extensively blackened, the pleurotergite chiefly pale brown, with a darker area on the cephalic portion. Halteres dark brown, the base of the stem and apex of the knob obscure yellow. Legs with the coxae dark brown basally, the tips obscure yellow; trochanters obscure brownish-yellow; femora with the bases narrowly obscure yellow, passing through brown to dark brown, the tips blackened, preceded by a relatively narrow yellow ring; tibiae brownish-black, the bases very narrowly obscure yellow, with a vague diffuse paler ring before the tips; basitarsi light brown, the outer segments passing into darker brown. Wings with a strong yellowish ground-colour, the base and costal region brighter; a heavy solid brown pattern, arranged as follows: At Sc_2; a prearcular spot; a large postarcular spot extending from costa to vein M; a large area at origin of Rs, reaching costa and continued along vein M as a conspicuous seam; broad seams along the cord and outer end of cell 1st M_2; large marginal clouds at ends of veins R_{1+2} and R_3, with smaller marginal clouds on the other longitudinal veins; broad seams on the veins back from the margin and a narrow apical margin completely surrounding the wing from vein R_4 back to the anal region; all of the above tend to restrict the ground-colour beyond the cord to small isolated patches; anal and cubital veins broadly seamed with brown; veins brownish-black, C and Sc somewhat brighter; no yellow seams surrounding certain of the veins, as in *pristina*. Venation: Sc_1 and Sc_2 both ending shortly beyond the origin of R_{2+3}; Rs angulated and spurred at origin; R_{2+3+4} about one-half longer than m-cu; R_2 pale yellow, a little shorter than R_{1+2}; m more arcuated than the outer deflection of M_3; m-cu at midlength of the long cell 1st M_2.

Abdominal tergites dark brown, the caudal margins of the segments restrictedly paler, the intermediate tergites somewhat brighter; a narrow dark lateral stripe; basal sternites yellow, the outer segments darker. Ovipositor with the shields brownish-yellow; valves relatively short and powerful, dark reddish horn-colour.

Holotype, ♀, Barrington Tops, January, 1925 (S.U. Zool. Exp.).

The only described species with which *A. munifica* might be confused is *A. pristina* (Alexander) of Victoria, which differs conspicuously in the wing- and leg-pattern and in the position of m-cu.

Limnophila edita, n. sp.

Belongs to the *pilosipennis* group; general coloration brownish-yellow; posterior vertex dark brown; legs yellow, only the outer segments of the tarsi darkened; wings light yellow; sparse macrotrichiae in the outer ends of cells R_4 to M_1; Sc_1 short, less than one-half m-cu.

♀. Length about 7·5 mm.; wing, 7·6 mm.

Rostrum pale brown; palpi dark brown. Antennae pale brownish-yellow, the outer segments darker; flagellar segments oval, the outer segments more elongate;

verticils longer than the segments. Head with the posterior vertex dark brown, sparsely pruinose, the anterior vertex pale silvery; occiput brownish-yellow.

Pronotum pale buffy. Mesonotum shiny brownish-yellow, without markings, the posterior sclerites more testaceous, the surface dull. Pleura concolorous with the postnotum, without markings, the surface very sparsely pruinose. Halteres pale yellow. Legs with the coxae testaceous yellow; remainder of the legs yellow, the outer segments of the tarsi darkened. Wings light yellow, the base and costal region even brighter coloured; veins pale brownish-yellow. Sparse macrotrichiae in outer ends of cells R_4, R_5 and M_1. Venation: Sc_2 not far from the tip of Sc_1, the latter alone being less than one-half m-cu; remainder of venation much as in *pilosipennis*, R_2 being obsolete or virtually so; Rs in alignment with R_{2+3+4} and the inner ends of cells R_4, R_5 and 1st M_2 in transverse alignment; veins R_3 and R_4 more divergent at margin; cells M_1 and 1st M_2 more elongate.

Abdominal tergites medium brown, the sternites brighter coloured; genital segment yellow. Ovipositor with the tergal valves relatively long, only gently upcurved.

Holotype, ♀, Barrington Tops, January, 1925 (S.U. Zool. Exp.).

Limnophila edita is generally similar to *L. pilosipennis* Alexander (Lord Howe Island), differing in the details of coloration, the short Sc_2, and the more restricted wing-trichiation.

Gynoplistia (Paralimnophila) fuscodorsata, n. sp.

Belongs to the *aurantiipennis* group; antennae 15-segmented, with eight short-branched segments in the male; thoracic dorsum chiefly dark brown, the pronotum and dorsal pleurites brighter coloured; wings brownish-yellow, cell C dark brown.

♂. Length about 9-10 mm.; wing, 9-10·2 mm. ♀. Length, 13-15 mm.; wing, 12-13·5 mm.

Rostrum and palpi dark brown. Antennae (♂) 15-segmented, the formula being 2+8+5; scapal segments obscure yellow; flagellum and branches dark brown, the extreme base of segments one and two obscure yellow; longest branch (flagellar segment four) about one-third longer than the segment; flagellar segment nine with the inner face toward apex a little produced. In the female, the antennae are likewise 15-segmented, the formula being 2+7+6, the branches being reduced to stout serrations; terminal two segments partially fused into a single segment. Head greyish-brown, the orbits clearer grey, the genae obscure reddish-brown.

Pronotum obscure yellow to orange-yellow, restrictedly darker medially. Dorsum of the mesonotum dark brown, the humeral region and lateral margins of the prescutum dark yellow; in cases, the prescutal stripes are better indicated, brown, narrowly margined with still darker brown, the surface vaguely pruinose, the interspaces a trifle more reddish; postnotal mediotergite a little brightened laterally near base. Pleura dark brown to reddish-brown, very sparsely pruinose; propleura and dorsopleural membrane brighter, orange-yellow; some specimens have the dorsal sternopleurite and ventral pteropleurite more yellowish to produce a vague longitudinal stripe, with a darker brown stripe immediately dorsad of it. Halteres dark brown. Legs with the coxae varying from obscure yellow to dark reddish-brown, the surface very sparsely pruinose; femora dark brown to black, their bases restrictedly obscure yellow, including approximately the basal third to fourth; tibiae dark brown, the tips passing into black; tarsi black, the basitarsi

a very little paler basally. Wings with a strong brownish yellow suffusion, cell C and the stigma dark brown, especially the former; the anterior radial field, the wing-base and cell Cu_1 somewhat brighter yellow; outer costal margin in cells R_2 and R_3 more saturated, especially near the veins; indistinct dusky clouds at origin of Rs, m-cu, outer end of cell 1st M_2 and the fork of M_{1+2}; 2nd anal cell more or less infuscated; veins pale brown, the costa darker, the prearcular veins more yellowish. Venation: Cell M_1 about one-half longer than its petiole; m-cu at or shortly beyond the fork of M, a little shorter than the distal section of Cu_1.

Abdomen, including the hypopygium, dark brown; outer sternites sometimes yellowish-brown; in the female, the base of the second tergite and the genital segment brighter yellow. Male hypopygium as in the subgenus, the tergite narrowed to a small rounded lobe that is tipped with a microscopic tubercle. Outer dististyle with the outer apical spine strongly decurved, the apical notch being small. Inner dististyle with a large, basal, fleshy lobe that is strongly setiferous, the outer flattened blade-like portion bearing a small subapical lobule. Gonapophyses slender, gradually narrowed outwardly, a trifle expanded just before the tip, this bulbous portion being further produced into a long, curved spine.

Holotype, ♂, Barrington Tops, January, 1925 (S.U. Zool. Exp.). Allotopotype, ♀. Paratopotypes, several ♂, ♀.

Gynoplistia fuscodorsata is readily told from *aurantiipennis* Alexander, by the small size, dark brown thoracic dorsum and abdomen, and the darker ground-colour of the wings.

Gynoplistia (Paralimnophila) remulsa, n. sp.

General coloration reddish to greyish-brown, the pleura with a broad, velvety, brownish-black longitudinal stripe; antennae (♂) 23-segmented, with 20 very long branches; halteres dark brown; legs black, the tips of the femora and bases of the tibiae narrowly white; tarsi largely white; wings with a strong fulvous to brownish tinge, variegated with dark brown.

♂. Length about 16 mm.; wing, 15·5 mm.; antennae, about 8 mm. ♀. Length about 20-22 mm.; wing, 16-17·5 mm.; antennae, about 4 mm.

Rostrum and palpi dark brown. Antennae (♂) 23-segmented, the formula being 2 + 20 + 1; scape and basal segments of the flagellum obscure yellow, the outer flagellar segments and all branches black; branches very long, the longest slightly exceeding one-third the length of the entire antenna; terminal segment elongate, the tip narrowed; pubescence of the flagellar branches long and delicate. In the female, the antennae are 19-segmented, the formula being 2 + 8 + 9; antennae obscure yellow, darkened outwardly; basal flagellar segments merely short-pectinate, the longest branch scarcely one-half the segment. Head grey to greyish-brown, clearer grey on the anterior vertex and posterior orbits.

Pronotum buffy, a trifle darker laterally. Mesonotal prescutum strongly narrowed in front of the large, pale, oval pseudosutural foveae; prescutum with four reddish-brown to greyish-brown stripes that are narrowly margined with slightly darker brown; intermediate stripes separated by a capillary dark brown to velvety-black median vitta that becomes very narrow and finally obsolete near the suture; lateral stripes bordered outwardly by a broad velvety brownish-black stripe that includes the cephalic portion of the stripe, thence extending back to the wing-root, more or less interrupted at the suture; humeral and lateral regions obscure greyish-yellow; posterior interspaces obscure buffy-yellow, narrowed in front, and, in cases, infuscated near the foveae; scutum obscure brownish-

yellow, the lobes reddish-brown to dark brown; scutellum brownish-yellow to brown, with a darker spot on either side; postnotum pale brown, with a yellowish pollen, more or less divided by a linear brown median vitta. Pleura buffy, with a broad velvety-black stripe extending from the cervical sclerites, crossing the entire pleura at near mid-height, becoming narrower and slightly less distinct on the postnotum; ventral pleurites and the sternites slightly more pruinose. Halteres dark brown, the extreme base of the stem obscure yellow. Legs with the coxae pale ochreous-grey, the small fore coxae with the apical half light grey; trochanters yellow; femora brownish-black, the bases very narrowly paler, the tips narrowly whitened; tibiae black, the bases narrowly whitened, the amount subequal to the femoral tips; tarsi white, with about the proximal three-fifths of the basitarsi black. Wings with a strong fulvous to brownish tinge, more intense in the entire radial field; cell C dark brown on basal half, the distal half yellowish-brown; cell Sc darkened basally and along the cephalic margin; stigma oval, dark brown; a sparse dark brown pattern, distributed as follows: Basal fourth of cell R, not quite reaching vein M; a large rectangular area at origin of Rs, not reaching M; smaller clouds at Sc_2, fork of Rs, fork of R_{2+3+4}, fork of M_{1+2}, posterior cord and outer ends of veins R_3, R_4 and R_5; paler brown washes along the distal third of vein R_5, anterior cord and outer end of cell 1st M_2, and beyond midlength of the cubital and anal cells; veins yellow, darker in the infuscated areas. Venation: R_{2+3+4} in alignment with Rs; R_2 about one-half R_{2+3} and about one-third R_{1+2}; cell R_3 strongly widened at outer end; m-cu close to the fork of M.

Abdominal tergites dark brown to yellowish-brown, more or less pruinose, the lateral margins darker; sternites paler. Ovipositor with the tergal valves elongate, slender, gently upcurved, reddish horn-colour, the bases blackened.

Holotype, ♀, Ulong, Eastern Dorrigo, New South Wales, 19th October, 1926 (W. Heron). Allotype, ♂, Barrington Tops, January, 1925 (S.U. Zool. Exp.). Paratypes, 1 ♂, 3 ♀, with the allotype.

Gynoplistia (Paralimnophila) harrisoni, n. sp.

General coloration clear light grey; antennae (♂) 22-segmented, with 19 long branches; mesonotal prescutum with three narrow brown stripes; pleura with a brown longitudinal stripe; legs black, the genua with white setae; tarsi extensively whitened; wings narrow, with a relatively sparse brown pattern.

♂. Length about 14 mm.; wing, 12·5 mm.; antennae, about 8 mm.

Rostrum light grey; palpi brownish-black. Antennae (♂) 22-segmented, the formula being 2 + 19 + 1; scapal segment dark brown, dusted with grey; remainder of organ brownish-black, the basal segments of the flagellum vaguely paler; longest branch approximately one-fourth the length of the entire antenna; terminal segment elongate, a little dilated just before the apex; pubescence of the flagellar segments long and delicate. Head clear light grey, the vertex with a longitudinal brown marking.

Pronotum light grey. Mesonotal prescutum light grey, with three distinct brown stripes, the median stripe paler in front, narrowed behind, crossing the suture, divided by a more or less distinct darker brown median vitta; lateral stripes very narrow; pseudosutural foveae distinct, black; scutum light grey, each lobe with a dark brown mark, the median area darkened, as described above; scutellum and postnotum light grey, with a capillary brown median vitta. Pleura clear light grey, with a brown longitudinal stripe extending from the cervical sclerites across the dorsal sclerites to beneath the wing-root. Halteres

obscure yellow, the knobs dark brown. Legs with the coxae pale, sparsely pruinose; trochanters obscure yellow; femora black, the bases obscure yellow, narrowest on the fore femora where about the basal fourth is included, broadest on the hind femora where it includes about the basal third; tips of femora and bases of tibiae blackened, but provided with conspicuous, snowy-white setae, most conspicuous on the posterior legs; tibiae black; basitarsi black, the distal two-fifths whitened; tarsal segments two and three whitened, with white setae and darkened tips; remainder of tarsi darkened, with white setae. Wings relatively long and narrow, with a brownish tinge; cells C and Sc and the stigma dark brown; paler brown washes at origin of Rs; beyond midlength of cell R, adjoining vein R; along the cord and outer end of cell 1st M_2; tip of R_3 and fork of M_{1+2}; and as vague seams to most of the veins; outer margin of cell R_3 more narrowly and heavily darkened; veins dark brown. Venation: R_2 about one-half R_{2+3}; R_{1+2} relatively long, about equal to m-cu; cell M_1 nearly twice its petiole; m-cu at about one-third its length beyond the fork of M.

Abdomen dark brownish-grey, the lateral margins of the tergites narrowly more yellowish.

Holotype ♂, Barrington Tops, January, 1925 (S.U. Zool. Exp.). Paratopotypes, 2 ♂.

This interesting *Paralimnophila* is named in honour of the late Professor Launcelot Harrison, of the University of Sydney.

Gynoplistia (Paralimnophila) barringtonia, n. sp.

General coloration grey; prescutum with four dark grey stripes that are narrowly margined with dark brown; pleura light grey, with a narrow, velvety black longitudinal stripe; femora and tibiae black, the genua narrowly white; tarsi extensively white; wings whitish, with a heavy brown pattern, the costal region dark brown.

♀: Length about 19 mm.; wing, 15·5 mm.; abdomen alone about 13·5 mm.

Rostrum dark, sparsely pruinose; palpi black. Antennae with the scapal segments obscure brownish-yellow, the first segment a little darker and vaguely pruinose; flagellum broken. Head light grey, the anterior vertex behind the antennal bases a little darker.

Pronotum buffy, the region between the scutum and scutellum darkened. Mesonotal prescutum with four dark grey stripes that are narrowly margined with dark brown, the humeral region and lateral margins obscure yellow, sparsely pruinose; posterior interspaces moderately dark reddish-brown, sparsely pruinose, paler than the stripes; pseudosutural foveae relatively long and narrow, dark reddish-brown; scutum pale, sparsely pruinose, the centre of each lobe very extensively darkened, scutellum dark; postnotal mediotergite light grey, with a relatively indistinct median brown line. Pleura clear light grey, with a narrow but conspicuous velvety black stripe that extends from the cervical sclerites to beneath the wing-root; anterior spiracle and a small spot on the dorsal pteropleurite blackened; dorsopleural region buffy behind. Halteres pale brown, the base of the stem restrictedly brightened, the knobs dark brown. Legs with the coxae pale yellow, sparsely pruinose; trochanters yellow; femora black, the bases obscure yellow, the amount including approximately the basal third or fourth; extreme tips of the femora and bases of the tibiae pale yellow, with white setae; remainder of tibiae black; basitarsi brownish-black, the distal third white; tarsal segments two and three white, with pale setae; terminal two

segments dark; two stout black spines at tip of each of tarsal segments one and two. Wings with a whitish ground-colour, heavily patterned with brown; cell C dark brown; cell Sc similar, the outer end more yellowish; large conspicuous brown clouds as follows: Base of cell R; origin of Rs; a complete seam extending from the slightly darker stigma across the wing; outer end of cell 1st M_2; tip of R_3 and fork of M_{1+2}; wing-apex narrowly but extensively darkened, deepest in cell R_3; most of the longitudinal veins near the wing-tip seamed with brown; a broad, paler brown seam on the distal half of vein M, with others along vein 1st A and as marginal clouds in both anal cells; cell Cu_1 darker brown; the whole effect thus produced is a heavily-patterned wing; veins pale brown, darker in the infuscated areas, more yellowish in the posterior region of the wing-base. Venation: R_{2+3+4} straight, subequal to R_{2+3}; R_2 a little less than one-half R_{1+2}; cell M_1 nearly twice its petiole; m-cu shortly before midlength of cell 1st M_2.

Abdominal tergites brownish-grey, more pruinose laterally; sternites more reddish-brown, more dusky laterally, with a longitudinal row of black punctures on either side. Ovipositor with the tergal valves relatively slender, gently upcurved; valves reddish horn-coloured, the bases darker.

Holotype ♀, Barrington Tops, January, 1925 (S.U. Zool. Exp.).

In its heavy wing-pattern, the present species agrees most closely with *G.* (*P.*) *flavipes* Alexander (Tasmania), differing in the size, conspicuously whitened genua, and the details of body- and wing-coloration.

Gynoplistia (Paralimnophila) mystica, n. sp.

Thorax brownish-grey, with four nearly concolorous stripes that are narrowly margined with dark brown; scutal lobes similarly ringed with brown; pleura extensively blackened; femora obscure yellow, with a brown subterminal ring; wings creamy, with an extensive spotted, dotted and clouded pattern.

♂. Length about 10 mm.; wing, 10 mm.

Rostrum dark brown, sparsely pruinose; palpi dark brown. Antennae with the scapal segments yellow; flagellum broken. Head dark grey.

Pronotum buffy-grey. Mesonotum brownish-grey with four almost concolorous stripes, the intermediate pair behind a little brighter; intermediate stripes in front passing into grey; caudad of the level of the pseudosutural foveae, the stripes conspicuously margined with dark brown; lateral stripes grey, similarly margined with brown, the lateral margin being broader and more intensely coloured; lateral margin of sclerite clearer buffy-grey; pseudosutural foveae large, pale; scutum pale brownish-grey, each lobe with a slightly more brownish centre that is completely bordered with dark brown to form a conspicuous ring; scutellum and postnotum buffy-grey, each with a capillary median brown vitta. Pleura almost covered by a broad black stripe that extends from the cervical sclerites across the pleurotergite, the narrow dorsopleural region buffy-grey, the ventral portion of the sternopleurite concolorous. Halteres pale brown, the base of the stem narrowly obscure yellow, the knobs dark brown. Legs with the coxae pale yellow, the basal half of the fore coxae infuscated; trochanters obscure yellow; femora obscure yellow, darkened outwardly, forming a relatively narrow subterminal brown ring before the narrow yellow apex; tibiae obscure yellow, the tips narrowly infuscated; basitarsi with the proximal three-fifths a trifle infuscated, most evident on the fore tarsi, the posterior basitarsi more uniformly pale yellow; remainder of the basitarsus and tarsal segments two to four obscure

yellow; terminal tarsal segment dark brown. Wings with a creamy ground-colour, handsomely spotted and clouded with brown; cell C infumed on basal portion; the largest brown clouds are near the base of cell R, at origin of Rs, the stigma, and as a broad seam on the anterior cord; smaller clouds at base of vein M, on the posterior cord and outer end of cell 1st M_2; tip of vein R_3 and fork of M_{1+2} clouded; cells 1st A and 2nd A with a conspicuous pale brown wash near midlength; conspicuous darker brown marginal spots at ends of all longitudinal veins and on Sc_2, that at 2nd A largest; a series of small dots on certain of the veins, including the outer end of vein M; Cu, one being larger; at base of R_5 and along vein M_3; a dusky wash in outer end of cell R_5; veins pale, dark brown in the infuscated areas. Venation: R_{2+3+4} a little longer than R_{2+3} and R_{1+2}; cell M_1 longer than its petiole; cell 1st M_2 relatively short and deep, with m-cu at or shortly before midlength.

Abdomen brownish-yellow, the segments narrowly margined laterally and caudally with darker brown; hypopygium dark brown. Male hypopygium as in the subgenus. Outer dististyle chitinized to the base, the stem relatively slender, the apex expanded, the outer apical angle a slender, curved spine, the inner apical angle a conspicuous obtuse lobe. Inner dististyle relatively long, the base very conspicuous, setiferous and elevated into two obtuse lobules; apex a flattened, obtuse blade.

Holotype ♂, Barrington Tops, January, 1925 (S.U. Zool. Exp.).

G. (*P.*) *mystica* is most closely related to *G.* (*P.*) *puella* Alexander (Victoria) from which it differs in the body-coloration and the more abundantly spotted and dotted wing-pattern.

GYNOPLISTIA (GYNOPLISTIA) FLAVOFEMORATA, n. sp.

General coloration of the thorax blackish to bluish-green; antennae 19-segmented, with 12 branched segments; femora chiefly yellow; posterior tibiae with a very broad, pale yellow ring immediately before the apex; halteres obscure yellow; wings with a faint dusky tinge, nearly immaculate except for the stigma; abdominal segments two to eight reddish-yellow, the hypopygium blackened.

♂. Length, 12·5-14 mm.; wing, 9·5-10·5 mm.

Rostrum dark, the palpi dark at extreme base, the outer segments obscure fulvous. Antennae (♂) 19-segmented, the formula being 2 + 2 + 10 + 5, brownish-black throughout; longest branch approximately two-fifths the length of the flagellum; no branch on flagellar segment 13, as in *fergusoniana*. Head shiny blue-black, with violaceous reflections.

Mesonotal prescutum and scutum ranging from black, with greenish reflections, to bluish-green, the surface with microscopic transverse striolae; scutellum in the type fulvous, in the paratypes black; parascutella black; post-notum dark, with violaceous reflexions, the surface with transverse basal and longitudinal discal striolations; postnotal pleurotergite with the conspicuous tubercle reddish beneath. Pleura almost entirely dull, pruinose, the sternopleurite and pleurotergal tubercle shiny. Halteres short, obscure yellow, the extreme base of the stem darker. Legs with the coxae dark, the surface pruinose; trochanters obscure yellow; femora yellow, the upper surface of the posterior femora more infuscated; tibiae and tarsi black, the posterior tibiae with a broad, yellow, nearly terminal annulus that includes approximately two-fifths of the whole extent of the tibia, the extreme tip darkened; tibial spurs and the tarsi much shorter than in *fergusoniana*. Wings with a faint dusky tinge, the base and costal region pale

yellow; stigma oval, dark brown, cell Sc infuscated; no distinct dark pattern other than the above. Macrotrichiae relatively sparse, on vein R_3 including only about six to ten scattered trichiae. Venation: R_4 almost straight; cell R_3 not conspicuously widened at margin.

Abdomen with the basal tergite blue-black; following tergites reddish-yellow, the apices of the segments a little darker, the surface with metallic reflections; the corresponding sternites more uniformly fulvous-yellow; hypopygium blackened. Male hypopygium with the outer dististyle very small, elongate-oval. Inner dististyle gently curved to the acute apex, the inner or concave face provided with small erect setae.

Holotype, ♂, Millgrove, Victoria, altitude 3,900 feet, 21st January, 1927 (F. E. Wilson); in the National Museum, Victoria. Paratypes, 1 ♂, Kosciusko, 7th December, 1922 (A. J. Nicholson), in the Macleay Collections; 1 ♂, Barrington Tops, January, 1925 (S.U. Zool. Exp.), in the author's collection.

Gynoplistia flavofemorata resembles *G. fergusoniana* Alexander (New South Wales) in the general coloration of the wings and body, the thoracic sculpture and in the pattern of the posterior tibiae. It differs in the structure of the antennae, the yellow halteres, trichiation of the wing-veins and the structure of the legs.

GYNOPLISTIA (GYNOPLISTIA) WESTWOODI OPIMA, n. subsp.

♀. Length about 17 mm.; wing, 14 mm.

Generally similar to the typical form, differing as follows: Antennae 20-segmented, the formula being 2+2+8+8; last branch longer than the segment that bears it. Brown marking on anepisternum darker coloured and more restricted in amount, the greyish-white pubescence very dense. Wings with the brown pattern much heavier, especially the post-arcular marking in cells R and M which is broadly connected along cell Cu with a spot near the outer end of cell 1st A; mark at origin of Rs large, subquadrate; cell Sc and adjoining portions of cell C conspicuously darkened; dark band at the cord wider, extending distad about to the level of the outer end of cell 1st M_2; dark spots in cell 2nd A and adjoining portion of cell 1st A more clearly delimited, geminate. Macrotrichiae of veins more sparse, on Rs being restricted to the distal third and only five or six in number. Abdomen with tergites two to four bronzy-yellow; segments five to seven more elongate, producing a longer abdomen.

Holotype ♀, Barrington Tops, January, 1925 (S.U. Zool. Exp.).

GYNOPLISTIA (GYNOPLISTIA) NICHOLSONI, n. sp.

Head and thorax velvety-black; abdomen brick-orange; femora, tibiae and basitarsi orange, their tips blackened; halteres orange; wings luteous, the base orange; costal margin black; a clearly defined brownish-black pattern; veins beyond the cord almost without macrotrichiae.

♀. Length about 20 mm.; wing, 15 mm.

Rostrum and palpi black. Antennae black throughout, 19-segmented, the formula (♀) being 2+2+7+8; branch of the third flagellar segment occupying a plane that is about intermediate between those of segments two and four; longest branch (flagellar segments four to six) nearly three times the segment; branch of flagellar segment nine subequal to the segment; flagellar segment ten with the face merely protuberant; remaining flagellar segments subcylindrical, crowded, the terminal segment about twice the length of the penultimate, strongly

constricted near midlength and apparently formed by the fusion of two segments. Head black.

Prothorax and mesothorax deep velvety-black; prosternum on either side produced ventrad into a hemispherical lobe that is densely provided with very short setae; sternopleurite and ventral portion of anepisternum subglabrous. Halteres short, orange. Legs with the coxae velvety-black; trochanters black; femora orange, the tips conspicuously blackened, most narrowly on the fore femora where the amount is scarcely one-half that of the corresponding blackened apex of the tibia; on the middle femora the amount is greater, including more than the distal quarter and subequal in amount to the blackened mid-tibial apex; on the hind femora, the black is very extensive, including more than two-fifths of the segment and about one-half wider than the blackened apex of the corresponding tibia; tibiae orange, the tips blackened as described above; tarsi black, all basitarsi orange, with only the tips narrowly blackened; on the posterior tarsi, the proximal half of the second tarsal segment is obscure orange. Wings pale luteous, handsomely patterned with brownish-black, the base broadly and conspicuously orange; cell C beyond arculus blackened; base of cell Sc similarly darkened, the outer portion adjoining vein R more yellowish; a series of clearly delimited dark spots as follows: Bases of cells R and M; origin of Rs, reaching vein M; a broad band at the cord, including the stigma, suffusing cell 1st M_2 except for two small droplets of the ground-colour, sending a narrower seam along vein Cu_1 to the wing-margin; wing-tip conspicuously darkened, including the outer ends of cells R_3, R_4 and R_5, the outer two-thirds of M_1 and the extreme outer end of cell 2nd M_2; a very conspicuous, clearly defined, oval spot in cell 1st A adjoining the vein shortly before its outer end; a second, more irregular spot crosses vein 2nd A near midlength, the majority lying in cell 2nd A; veins black in the darkened areas, pale yellow in the luteous regions, the base and pale costal margin more orange. Macrotrichiae of veins corresponding in colour to the veins themselves. Costa at base incrassated and strongly setiferous. Macrotrichiae of veins beyond the cord very small and sparse, there being none on R_{2+3}, R_3, R_4 or the medial veins, and only a scattered series of about a dozen on vein R_5. Venation: R_{2+3+4} short, a little longer than r-m; cell M_1 nearly one-half longer than its petiole; m-cu at or just beyond midlength of cell 1st M_2.

Abdomen with the first segment black; segments two to seven dull brick-orange; remaining segments black; ovipositor with the valves yellowish horn-colour, the tergal valves rather strongly upcurved.

Holotype ♀, Barrington Tops, January, 1925 (S.U. Zool. Exp.).

This very distinct species is named in honour of Mr. A. J. Nicholson, of the University of Sydney, who has collected several interesting Tipulidae on the Barrington Tops and on Kosciusko. It is very distinct from all described species, coming closest, perhaps, to *Gynoplistia bella* Walker and *G. westwoodi* Skuse.

Gynoplistia (Gynoplistia) cultrata, n. sp.

General coloration black; antennae (♂) 17- to 19-segmented, with 12 branched segments; pleura heavily pruinose; halteres dark; legs black, the femoral bases rather narrowly fulvous; wings whitish, with a relatively sparse brown pattern, the costal cell pale; abdomen violaceous; male hypopygium with the dististyle powerful, shaped somewhat like a pruning-knife.

♂. Length 9-11 mm.; wing, 9·5-11·5 mm.

Head and appendages black. Antennae (♂) 17 to 19-segmented, the formula being 2 + 2 + 10 + 3 to 2 + 2 + 10 + 5; branch of first flagellar segment a little more than three times the segment; longest branch (flagellar segment five) approximately six times the segment; flagellar segment twelve with the branch about equal to the segment; number of simple terminal segments varying from three to five.

Pronotum and mesonotum shiny black, the scutellum and median region of the scutum with long yellow setae. Pleura heavily pruinose. Halteres brown, the knobs blackened. Legs with the coxae pruinose; trochanters black; remainder of legs black, the femoral bases rather narrowly fulvous, this including about the proximal third of the fore femora and a little more than the proximal quarter of the posterior femora. Wings whitish, including the costal cell; cell Sc and the stigma dark brown; a relatively sparse brown pattern, arranged as follows: At origin of Rs; a seam on anterior cord; cell Cu_1; brown seams on the distal half of vein M, M_{3+4} and Cu_1; wing-tip broadly but not conspicuously infumed, in cases restricted to seams along the veins in this region; outer end of cell 1st M_2 with a narrow seam; a small brown cloud in cell 1st A adjoining the vein at near two-thirds the length; a similar marking at near midlength of vein 2nd A; veins dark brown. Venation: R_{2+3+4} very short; veins R_2 and R_4 divergent; cell R_3 wide at margin; cell M_1 about one-half longer than its petiole; m-cu before midlength of cell 1st M_2.

Abdomen brown, including the hypopygium, the tergites with strong violaceous reflections; lateral margins of the segments with relatively conspicuous yellow setae. Male hypopygium with the single dististyle very powerful, terminal in position, shaped somewhat like a pruning-knife, being flattened, widened distally, the apex obliquely truncated, with the inner apical angle produced into a sharp, gently curved, blackened point.

Holotype ♂, Barrington Tops, January, 1925 (S.U. Zool. Exp.). Paratopotypes, 6 ♂.

In its extensive black coloration, *Gynoplistia cultrata* somewhat resembles *G. simplex* Alexander, which has a very different hypopygium.

Gynoplistia (Gynoplistia) histrionica, n. sp.

General coloration shiny-black and reddish-yellow; prescutum and scutum black; pleura polished, without pruinosity, reddish with a transverse black girdle and a large spot on the pleurotergite; legs yellow, the tips of the femora, bases and tips of the tibiae and the tarsi black; wings pale luteous, with a conspicuous brown pattern; abdomen shiny-yellow, the lateral margins of tergites two and three shiny-black.

♀. Length about 11-11·5 mm.; wing, 8·5-9·5 mm.

Rostrum reddish-yellow; palpi dark brown. Antennae (♀) 16-segmented, the formula being 2 + 8 + 6; scape and basal segment of flagellum obscure yellow, the remaining segments and all pectinations black; tip of first scapal segment more or less infuscated; longest branch about one-half longer than the segment; last branch scarcely one-half the segment; terminal segment nearly twice the penultimate and evidently representing two fused segments. Head shiny-reddish, with a narrow and more or less indistinct blackened band across the vertex connecting the posterior angles of the eyes.

Pronotum shiny-reddish. Mesonotal prescutum and scutum polished black, only the humeral regions of the former restrictedly obscure reddish; surface of prescutum nearly smooth; median region of suture more or less reddish; median

area of scutum behind restrictedly reddish; scutellum obscure reddish, the parascutella blackened; postnotal mediotergite shiny-reddish. Pleura reddish, with a broad, complete black girdle that includes all of the anepisternum and sternopleurite, leaving the propleura, pteropleurite and meron of the ground-colour; pleurotergite black, narrowly margined dorsally and caudally with reddish. Pleura highly polished, without pubescence. Halteres obscure orange, the knobs vaguely to more strongly infuscated. Legs with the coxae and trochanters orange; femora yellow, the tips broadly and abruptly blackened, the amount subequal on all the legs; tibiae yellow with the bases and apices narrowly but conspicuously blackened, the latter a little more extensively so; tarsi black. Wings with a pale luteous tinge, the base and costal margin more strongly flavous; a restricted but conspicuous dark wing-pattern, as follows: An irregularly circular spot at origin of Rs, not reaching M; stigma broadly connected with an area on the anterior cord to form a conspicuous triangle; posterior cord and outer end of cell 1st M_2 more narrowly seamed; wing-tip broadly paler brown, including almost all of cell M_1; cell Cu_1 dusky, including pale brown clouds in the basal half of cell Cu and as a broad diffuse marginal cloud on the distal section of Cu_1; veins dark brown, the prearcular veins yellow. Macrotrichiae abundant, including close series on the radial veins. Venation: Rs angulated at origin; R_{2+3+4} very short, the basal section of R_5 correspondingly lengthened; cell R_3 at margin very wide; cell M_1 a little shorter than its petiole; m-cu at near midlength of cell 1st M_2.

Abdomen shiny reddish-yellow, conspicuously variegated with shiny black on the lateral margins of segments two and three; dorsum of tergites three to six more or less blackened; sternites more or less blackened, especially laterally, the caudal margins narrowly yellowish. Ovipositor very elongate, the tergal valves bright reddish horn-colour, nearly straight, the tips gently upcurved.

Holotype ♀, Barrington Tops, January, 1925 (S.U. Zool. Exp.). Paratopotypes, 2 ♀.

Gynoplistia (Gynoplistia) pammelas, n. sp.

General coloration shiny coal-black; antennae (♀) 16-segmented, with 9 branched segments; pleura and coxae heavily pruinose; halteres and legs black; posterior tibiae with a narrow white ring; wings strongly infumed, the costal region, a cloud at origin of Rs and a broad band along the cord darker; Sc relatively short, both Sc_1 and Sc_2 ending about opposite the fork of Rs; cell M_1 about equal to its petiole.

♀. Length about 11·5 mm.; wing, 9·5 mm.

Head and appendages entirely black. Antennae 16-segmented, the formula (♀) being 2 + 2 + 7 + 5; longest branch about two and one-half times the segment; branch of the ninth flagellar segment about one-half the segment; terminal segment enlarged, approximately twice as long as the penultimate.

Mesonotum highly polished, black, with the impressions subobsolete. Pleura with a heavy grey pubescence, especially the ventral pleurites. Halteres black. Legs with the coxae heavily pruinose; remainder of legs black; posterior tibiae with a conspicuous snowy band at approximately its own length, or a little less, from the tip. Wings with a strong dusky tinge, the costal region still darker; two conspicuous dark brown areas, a quadrate one at origin at Rs, not attaining M, and a conspicuous transverse band extending from the stigma to m-cu, broadest on the anterior cord, the centre of cell 1st M_2 pale; wing-tip a little more infumed; veins brownish-black. Macrotrichiae relatively abundant, on the radial veins

except R_{1+2} and the outer end of R_3; a series of about 15 on the distal two-thirds of Rs; no macrotrichiae on M_{1+2}, M_2 or M_3. Venation: Sc relatively short, Sc_2 at the tip of Sc_1, both ending opposite the fork of Rs; Rs relatively long, weakly angulated at origin; R_4 sinuous, on outer half deflected strongly caudad; cell M_1 relatively short, subequal to its petiole.

Abdomen shiny-black, with very slight greenish reflections; ovipositor black.

Holotype ♀, Barrington Tops, January, 1925 (S.U. Zool. Exp.).

Gynoplistia pammelas is closely allied to *G. fumipennis* Walker (Tasmania), differing in the antennal structure, the more shiny thoracic notum, the leg-coloration, wing-pattern and the details of venation and trichiation.

Tasiocera barringtonensis, n. sp.

♂. Length about 3·3 mm.; wing, 4·7 mm.; antenna, about 5·2 mm.

Generally similar to *Tasiocera attenuata* Alexander (Tasmania), differing especially in the details of structure of the male hypopygium.

Antennal scape obscure yellow; flagellum brownish-black. Head dark grey. Pronotum and anterior lateral pretergites obscure yellow. Mesonotum shiny-brown, the humeral regions a little brighter. Wings with a stronger brownish suffusion. Venation: Cell R_3 sessile or very short-petiolate; vein 2nd A unusually long, extending to shortly beyond the origin of Rs. Abdomen dark, the hypopygium reddish-brown. Male hypopygium generally as in *attenuata* (*Ann. Mag. Nat. Hist.*, (9) 17, 1926, fig. 4, p. 170) in the subterminal dististyle and heavily blackened asymmetrical phallosome. Basistyle with the apex produced and constricted near base, the tip with about five powerful spinous bristles. Dististyle relatively long and slender, the outer half very narrow, with apical and marginal denticles, including a larger subterminal tooth. Phallosome blackened, the head portion directly prolonged into a long beak-like spine; the spine on the disk of the phallosome is greatly dilated beyond the base, the actual attachment narrow, the dilated portion produced into an acute spine, as well as the more blackened finger-like portion in *attenuata*.

Holotype ♂, Barrington Tops, in *Fagus* brush, January, 1925 (S.U. Zool. Exp.). Paratopotype, ♂.

Molophilus macleayanus, n. sp.

Belongs to the *gracilis* group, *ruficollis* subgroup; general coloration light brown; antennae (♂) elongate, nodulose; halteres dark; wings broad, pale brown, with dark macrotrichiae; male hypopygium with the basal dististyle a small compact black mass that terminates in a long slender rod, with a smaller lobe bearing a group of about four small spines at apex.

♂. Length about 3·3·2 mm.; wing, 4·5-4·7 mm.; antenna, about 3·5 mm.

Rostrum and palpi black. Antennae (♂) elongate, longer than the body, brownish-black; antennae strongly nodulose, the basal two-thirds of the flagellar segments beyond the first strongly dilated and bearing a whorl of long conspicuous verticils; apical pedicel glabrous. Head brownish-black.

Mesonotum light brown, the humeral region of the prescutum obscure yellow. Pleura pale brown, the dorsal region vaguely darker. Halteres dark brown, the base of the stem restrictedly pale. Legs with the coxae and trochanters yellowish-testaceous; remainder of legs yellowish-brown, densely clothed with dark setae, the terminal segments darker brown; posterior legs more uniformly pale. Wings broad, with a pale brown suffusion, the veins darker brown; macrotrichiae dark

brown, the costal fringe very long and dense. Venation: R_{2+3} shorter than R_{4+5}; petiole of cell M_3 at least three times m-cu; vein 2nd A relatively short, ending a little before m-cu.

Abdomen, including the hypopygium, dark brown. Male hypopygium relatively small and compact; basistyles with the lobes very broad and obtuse. Outer dististyle with the stem long and slender, the apex bifid, the outer arm strongly expanded, the inner arm more slender. Basal dististyle a heavily blackened compact mass that is prolonged apically into a slender, gently curved rod; before the apex, on the outer face at the base of the rod, a small stout lobe that terminates in a group of about four irregular spines; this lobe in a slightly different plane from that of the apical spine. Aedeagus relatively short, yellow.

Holotype ♂, Barrington Tops, in *Fagus* brush, January, 1925 (S.U. Zool. Exp.). Paratopotype, ♂.

Molophilus macleayanus is a very distinct species, most nearly allied, perhaps, to *M. variistylus* Alexander (Tasmania). It is named in honour of Sir William Macleay, eminent patron of the sciences in Australia.

MOLOPHILUS FLAVOCINGULATUS, n. sp.

Belongs to the *gracilis* group and subgroup; head obscure yellow, the disk of the vertex darker; scutellum obscure yellow; halteres yellow; abdomen brown, the segments conspicuously ringed caudally with yellow; male hypopygium with the dorsal lobe of the basistyle an acute spine; ventral lobe very small; outer dististyle attached laterally, the outer end a long acute spine; inner dististyle a stout yellow rod that bears an acute black lateral spine beyond midlength.

♂. Length about 3·8 mm.; wing, 5·3 mm.

Rostrum and palpi black. Antennae with the basal three or four segments brownish-yellow, the succeeding segments passing into brown; terminal flagellar segments broken; flagellar segments oval. Head obscure yellow, the disk of the vertex extensively brownish-grey.

Pronotum yellowish-brown, the scutellum brighter; lateral pretergites pale sulphur-yellow. Mesonotal prescutum and scutum rich reddish-brown, the surface slightly pruinose, especially laterally; humeral region of prescutum obscure yellow; scutellum grey, the apex broadly obscure yellow; postnotum dark brown. Pleura dark brown, slightly paler ventrally; dorso-pleural region conspicuously yellow. Halteres pale yellow, the knobs very conspicuously so. Legs with the coxae dark brown, paler apically and mesially; trochanters obscure yellow; remainder of legs broken. Wings with a strong yellow tinge, the base and costal region somewhat more saturated; anal angle weakly darkened; veins pale. Venation: R_{2+3} nearly three times R_{4+5}, gently arcuated; petiole of cell M_3 a little less than twice the oblique m-cu; vein 2nd A relatively long, ending shortly beyond the cephalic end of m-cu.

Abdominal tergites brown, the segments broadly and conspicuously margined caudally with bright yellow; sternites similar but the yellow caudal margins narrower, more obscure and ill-defined; hypopygium dark reddish-brown. Male hypopygium with the dorsal lobe of the basistyle prolonged into a conspicuous acute spine, the basal three-fifths stouter, setiferous, the distal spine yellowish horn-colour, the tip acute; ventral lobe of basistyle small, fleshy, shorter and smaller than the mesal lobe, the mesal face with relatively few conspicuous setae; mesal lobe of basistyle large and fleshy, with scattered setae and abundant microscopic setulae. Outer dististyle of very peculiar form, attached laterally,

the mesal end produced into a flattened, obtusely rounded blade, the lateral end soon bent at a right angle into a long, slender, nearly straight black spine that is about twice as long as the dorsal spine of the basistyle, its surface roughened. Inner dististyle a long yellow rod, gently sinuous, beyond midlength on the outer face bearing a long, curved, black spine; apex of the style a spear-shaped dusky head. Aedeagus relatively long and slender, in slides extending caudad to beyond the level of the mesal lobe of the basistyle.

Holotype ♂, Barrington Tops, on *Leptospermum*, Allyn Range, February, 1925 (S.U. Zool. Exp.), in poor condition.

THE GROWTH RINGS IN THE WOOD OF AUSTRALIAN ARAUCARIAN CONIFERS.

By W. D. Francis.
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(Plates x-xi.)

[Read 28th March, 1928.]

Introduction.

There is a widespread belief that the rings in the wood of Australian trees are not annual. Several circumstances have contributed to this assumption. The continent of Australia has been settled by people from the cool-temperate parts of Europe where many of the trees form fairly definite, yearly rings. In contrast with the cool-temperate parts of Europe and North America, Australia possesses a warmer climate and a more irregular rainfall. As an expression of climatic conditions the rings in the wood of trees grown in the warmer parts of Australia are much more uneven than those in the trees produced in Europe and the Northern United States of America and Canada. It remains for investigation to show to what extent the wood rings of Australian trees are of annual occurrence. This paper is intended as a contribution to the subject, although its scope is not confined to the duration of the rings.

Curiosity as to the age of trees arises from both aesthetic and utilitarian considerations. Admiration of the giants of the forest frequently evokes the question of their age. It is recognized that trees are among the longest-living of all organisms. To the forester, the age of timber-producing trees is an important economic question, as he bases upon it calculations relating to rate of production and cost of timber. In this respect foresters in Australia are at a disadvantage owing to the uncertain age of the constituent trees of the indigenous forests.

In the United States of America a considerable amount of work has been done on the growth rings of trees. In addition to estimating the age of trees, some of the American investigators have employed the growth rings to interpret climatic conditions in the past. The big tree (*Sequoia gigantea*) has been extensively investigated from this point of view and data extending back as far as 1000 B.C. have been compiled from it. While perusing some of the American literature the writer met with observations and conclusions concerning the nature and occurrence of growth rings. As these details are pertinent to the present investigation a very brief summary of them will be given.

A Partial Summary of American Work on Growth Rings.

Ernst Antevs (1925, p. 121) states that it is a well-known fact that young, vigorous trees are relatively far less influenced by external conditions than are old individuals. Rings formed when the trees are very old may for several reasons not be good. Further on (1925, p. 124) he remarks that just as growth

rings may be supernumerary, so also may they be less than normal in numbers. One-sided omission of rings in strongly excentric trunks is quite common. The number of elements decreases till the ring wedges out; but growth may also fail in the entire tree. The normal cause of dropped rings is insufficient nourishment.

A. E. Douglass (1919) made tests on trees of yellow pine (*Pinus ponderosa*) at Prescott, Arizona, in order to determine the time of formation of the red or autumn portion of the rings and the causes of the formation of double rings. The curves which he obtained as a result of the work seemed to indicate clearly that the chief cause of doubling is a deficiency of snowfall in the winter months, December to March. Much of the first growth of the trees in the spring must come from the melting of the autumn and winter snows. This appears to mean that if the winter precipitation is sufficient to bridge over the usual spring drought, the growth continues through the season, giving a large single ring which ends only in the usual red growth as the severity of winter comes on. If, however, the preceding winter precipitation has not been entirely adequate, the spring drought taxes the resources of the tree and some red tissue is formed because of deficient absorption in the early summer before the rains begin. When these rains come the tree continues its growth (1919, pp. 17, 18). The normal ring consists of a soft, light-coloured tissue which forms in the spring, merging into a harder, reddish portion which abruptly ends as the tree ceases growth for the year. It is indicated that the red tissue appears as the tree feels lack of sufficient moisture (1919, p. 20).

D. T. MacDougal (1921) investigated the growth of the Monterey pine (*Pinus radiata*) in the grounds of the coastal laboratory at Carmel, California. The seasons in the region are indeterminate as to frost and temperature features, but the rainfall occurs in the winter and growth depends upon the soil supply of water and the rising temperature, with the result that enlargement of the trunks continues until the soil moisture around the absorbing roots is depleted until it forms no more than 6 to 10 per cent. of the total weight (1921, p. 18). MacDougal was able to produce experimentally by irrigation a second layer of wood in a tree in the year 1920. In the early part of the year a layer 5 mm. in thickness was formed. Another layer of equal thickness was added in the later part of the year as a result of irrigation. The irrigation was carried out in July, after the soil moisture content had diminished to 5-7 per cent. Some double rings were observed in the wood of the trees and the investigator assumed that the doubling occurred in a single year, the second layer being caused by autumn rains (1921, pp. 21-3, 25).

Material Used in this Investigation.

Sections from the base of the stems of the following trees were used: a hoop pine (*Araucaria Cunninghamii*) at Crohamhurst; two trees of the same species in the neighbourhood of Gympie; and a bunya pine (*Araucaria Bidwilli*) in the neighbourhood of Gympie. The outer part of a section from the base of a Queensland kauri pine (*Agathis robusta*) at Kin Kin was also utilized.

The section from Crohamhurst was made available through the generosity of Mr. Inigo Jones. The tree was growing in the open. It measured 49 cm. (19·5 in.) in diameter at the base of the stem and attained a height of 22·5 metres (75 feet). The section supplied to the writer was cut at a distance of 45 cm. (18 in.) from the ground. Mr. Inigo Jones states that the area in which the tree grew was swept by a fire in November, 1894, and that the tree was a seedling in 1895. The

tree was felled early in June, 1926. It would take at least two years from the time of the fire for the young tree to attain the height of 45 cm., the point at which it was sectioned in 1926. Accordingly the tree could be considered to have existed for a maximum period of 30½ years from the time it reached the point at which it was sectioned until it was felled. The locality is situated about 20 miles from the sea in latitude 27° S. The climate is subtropical in character. According to figures supplied by Mr. Inigo Jones the mean maximum and minimum shade temperatures for the two warmest months of the year, December and January, are about 83° F. and 65° F. respectively. The mean maximum and minimum shade temperatures for the two coolest months, June and July, are about 66° and 45° respectively. The mean annual rainfall is 80 inches.

The material from the neighbourhood of Gympie was obtained through the courtesy of the Provisional Forestry Board of Queensland. It consisted of a section from the base of a hoop pine 53 cm. (21 in.) in stem diameter and 35 m. (117 ft.) in total height, a section from the base of a small hoop pine 7·3 cm. (2·9 in.) in stem diameter and 6 m. (20 ft.) in total height, and a section from the base of a bunya pine 75 cm. (30 in.) in stem diameter and 34 m. (113 ft.) in total height. The sections of the large hoop pine and the bunya pine were from trees of unknown ages. The small section of the hoop pine was taken from a plantation tree 8 years and 5 months old from the time of germination in the seed bed. Gympie is situated about 28 miles from the sea in latitude 26° S. The climate is subtropical in character. The mean maximum and minimum shade temperatures for December and January, as supplied by Mr. G. G. Bond, Divisional Meteorological Officer, are 85° F. and 68° F. respectively; the mean maximum and minimum shade temperatures for June and July are 69° and 42° F. respectively. The mean annual rainfall is 46 inches.

The Kin Kin section is from a Queensland kauri pine 135 cm. (54 in.) in stem diameter and about 36 m. (120 ft.) in total height. The section is from the base of the tree but only represents 27·5 cm. (11 in.) of the radius of the stem from the bark inwards. The locality is situated between Gympie and the sea in latitude 26° S. The climate is similar in a general way to that of Gympie. The mean annual rainfall is 57 inches.

All the localities from which the material was derived are situated in southern Queensland where the three wettest months are January, February and March.

No material of the North Queensland kauri pines (*Agathis Palmerstoni* and *A. microstachya*) was available for investigation.

General Observations upon the Growth Rings of Australian Araucarian Conifers.

The growth rings of the hoop pine, bunya pine and Queensland kauri pine consist of a light-coloured portion, presumably corresponding to the spring and early summer wood, and a darker or brown-coloured portion, presumably corresponding to the late summer or autumn wood. The transition from the light to the dark portion of the rings is generally a gradual one. As there is a marked difference in the temperature of the summer and winter seasons in southern Queensland it is reasonable to assume that the seasonal differences of temperature affect the growth of the wood of the Araucarian conifers under investigation. This consideration leads one to expect that annual rings may be formed by them in some measure at least.

The same degree of distinction and regularity in the growth rings as that characteristic of the wood of European and North American trees such as the English oak (*Quercus pedunculata*), English beech (*Fagus sylvatica*) and Oregon pine (*Pseudotsuga Douglasii*) is not shown by the wood of the subtropical specimens of Australian Araucarian conifers. The wood of the Australian Araucarian conifers contains scattered parts in which closely compressed rings occur and sometimes other scattered parts in which the rings are faint or entirely lacking. Very fine and numerous closely-compressed rings are particularly frequent in the innermost portion of the section of the bunya pine from the neighbourhood of Gympie. On the other hand the outer part of this section and the section of the outer part of the Queensland kauri pine from Kin Kin possess a fairly large number of areas in which the rings are either indistinct or quite lacking. Individual areas of this kind sometimes extend over a radial distance of 1 cm. (0·4 in.).

The fine, numerous and closely compressed rings of the innermost part of the section of bunya pine from the neighbourhood of Gympie may be due to the suppression of the tree in its youth. Suppression is assumed to indicate that the tree was crowded in a rain forest or other dense forest where the sunlight was meagre and growth retarded in consequence. The areas with ill-defined or absent rings in the outer part of the same section and in the section of the outermost part of the Queensland kauri pine from Kin Kin may be the result of successions of mild winters through which growth continued. Very fine rings alternating with broader, more regular ones in the sections of all the trees examined may be due to deficient spring or early summer rains or to the occurrence of warm periods in winter during which growth is reawakened. Deficient spring or early summer rains and comparatively warm periods during the winter months are not rare in southern Queensland. Douglass's work on the yellow pine (*Pinus ponderosa*) in Arizona, where dry springs occur, indicates that insufficient moisture in the early summer causes the formation of a ring in the wood of the trees he studied. In all probability rings are also produced in our conifers by an insufficient moisture supply in very dry springs or very dry early summers.

Of all the sections examined those of the hoop pine (*Araucaria Cunninghamii*) showed the greatest regularity in the occurrence of the rings. Two sections of hoop pine stems are represented by the photograph on Plate x. The ring boundaries are more sharply defined in old and mature trees than in young, fast-growing ones. The most marked uniformity in the breadth of the rings was observed towards the centre of the hoop pine from Crohamhurst and of the large hoop pine from the neighbourhood of Gympie. These sections are shown on Plate x. This circumstance is in accordance with Antevs's statement (1925, p. 121) to the effect that young, vigorous trees are relatively far less influenced by external conditions than are old individuals. The wedging-out or extinction of rings on one side of a tree, which is mentioned by Antevs (1925, p. 124), has been observed by the writer in the section of the bunya pine from the neighbourhood of Gympie. In this case it was associated with the slight excentric development of the stem.

The Occurrence of Annual Rings in Australian Araucarian Conifers.

From the partial summary of American literature given in this paper and from the writer's observations upon the material at his disposal it is concluded that all of the rings appearing in the sections of the Australian Araucarian

conifers do not represent the growth of single years. It appears highly probable that two, three or even more rings may be added to the woody cylinder in one year. Instances may also occur in which rings are omitted or are only imperfectly defined. The subtropical climate of the localities in which many of the Australian Araucarian conifers grow and the irregularity of the rainfall at times would appear to induce irregularity in the wood rings. It is to be expected that subtropical representatives of Australian Araucarian conifers would exhibit less uniformity in their wood rings than would coniferous trees in Arizona where there is an annual fall of snow. This yearly occurrence of snow could be anticipated to cause a cessation of growth in winter much more readily than the winter temperatures of subtropical Australia.

On the other hand there is evidence to show that there are rings in varying numbers in the wood of the sections of the hoop pine (*Araucaria Cunninghamii*) each of which was apparently produced in a single year. These rings are assumed to be annual ones. This statement applies only to the sections obtained and prepared for this investigation and more particularly to the section supplied by Mr. Inigo Jones from Crohamhurst. Regular or fairly uniform rings can be traced in about one-half of the Crohamhurst stem. The inner part of the stem shows an unbroken succession of ten fairly regular rings. The remainder of the stem of the same tree shows in places series containing two fairly uniform rings. These series of rings and the ten rings in unbroken succession from the centre of the tree outwards have the appearance of annual rings (see Plate x). As the approximate age of this tree is known, the probability of the fairly regular and serially-connected rings being annual can be tested. For this purpose the radial measurement of the tree was divided by the mean measurement of the width of the rings. If the quotient thus obtained approximates the known age of the tree it provides at least a partial proof that the rings measured are annual ones. By this method 27 was the quotient obtained and, as already stated, the tree had existed for a maximum period of 30½ years from the time it reached the plane in which it was sectioned until it was felled. This result is considered to substantiate, at least partly, the assumption that the fairly uniform rings occurring in succession in several series in the section are of an annual character. The discrepancy between the known age of the tree and its age as calculated by means of the annual rings represents an error of 11·5 per cent.

The same method was applied to the large section of the hoop pine (*Araucaria Cunninghamii*) of unknown age from the neighbourhood of Gympie. This tree measured 53 cm. (21 in.) in stem diameter. The breadth of 35 rings of fairly uniform size and occurring in series was measured. Their mean width was found to be approximately 2 mm. The radius of the stem divided by the mean width of the measured rings resulted in a quotient of 135, which is the estimated age in years of the tree.

This method of estimating the age of coniferous trees in subtropical Australia has its limitations. It can only be applied to examples in which series of fairly regular rings can be observed. Strongly compressed rings cannot be utilized and trees exhibiting excessively irregular rings are unsuitable. It appears probable that the method would minimize the age of a tree. This is deducible from the circumstance that the rings which are used would be those produced in favourable years when growth was continuous from spring to autumn wood.

The section of the bunya pine (*Araucaria Bidwilli*) from the neighbourhood of Gympie is not suitable for estimating the age of the tree from which it was

taken. It contains a very large number of closely compressed rings in the inner part and very irregular ones in the outer part.

The part of the section of the base of the stem of the Queensland kauri pine (*Agathis robusta*) from Kin Kin contains a number of fairly regular rings in series. The mean breadth of these rings was found to be 3 mm. It is estimated that this tree produced the outer 27·8 cm. (11 in.) of the radius of its stem in 93 years. If it grew at the same rate during the remaining, earlier part of its life, it is estimated that its total age is 228 years. When felled it was 135 cm. (54 in.) in diameter. Some of the very large trees of the species which once grew at Kin Kin attained a stem diameter of 240 cm. (8 feet). If these trees grew at the same rate as the one from which the section under investigation was taken, their age could be estimated at about 400 years. It is obvious that these estimates require more material for their confirmation or otherwise, as they are based on very meagre evidence.

In concluding this section of the paper it should be remarked that the subject of the occurrence of annual rings in Australian trees is worthy of further investigation. Although the study of wood rings in subtropical trees is of considerable interest both from the scientific and economic aspects, it might be anticipated that more definite conclusions could be formulated from an investigation of the rings in the wood of trees grown in the cooler parts of the continent.

Microscopic Features of the Growth Rings.

The rings in the wood of young, fast-growing trees are frequently more readily discernible to the unaided eye than by microscopic examination of thin, transparent sections. This conclusion was arrived at after studying the rings of the young hoop pine (*Araucaria Cunninghamii*) from the Forestry plantation in the neighbourhood of Gympie. Some difficulty was experienced in tracing in stained microtome sections rings which were visible to the unaided eye in smoothed sections of the stem of the tree. It is therefore evident that some of the rings in examples of this kind are not sharply defined in a microscopic sense. The growth rings in the wood of mature trees of hoop pine (*Araucaria Cunninghamii*) and bunya pine (*A. Bidwilli*) from Gympie and in the wood of the Queensland kauri pine (*Agathis robusta*) from Kin Kin are traceable in microtome sections. The photomicrographs reproduced on Plate xi show the minute structure of the rings. The most obvious microscopic feature consists of the reduction of the transverse measurement of the tracheids of the outer or brown portion of the rings corresponding in appearance to autumn or late summer wood. These tracheids are also characterized by their thicker walls. This thickening consists of an extension of the secondary cell wall or that part of the wall in which the greater amount of lignification, or transformation into wood, takes place.

Another feature of the outer or brown portion of the rings is the presence of bordered pits in the tangential walls of the tracheids. By far the greater number of bordered pits is situated in the radial walls. E. C. Jeffrey (1917) states that the tangential pits are characteristic of the end of the annual rings in conifers and that this condition is notable for example in tropical or subtropical species of the genus *Araucaria*. Tangential pitting has been observed by the writer in the outer or brown portion of the rings in the wood of the hoop pine, bunya pine and Queensland kauri pine. They are much more frequent in the Queensland kauri pine than in the two species of *Araucaria*. They are much smaller and much less prominent than the numerous bordered pits in the radial walls of the tracheids.

This observation applies to the hoop pine, bunya pine and Queensland kauri pine. The pits of the tangential walls of the tracheids are bordered ones. In the bordered pits in the tangential walls of the outer portion of the rings of the Queensland kauri pine, the middle lamella between the opposite apertures is considerably thickened and has the appearance of an extended torus. The thickened portion of the middle lamella stains intensely with iron-haematoxylon and is responsible for much of the darkened appearance of the tangential bordered pits shown in Fig. 3, Plate xi.

It has not been possible for the writer to show that the rings in which the tangential pitting is seen are of an annual character. This kind of pitting was observed chiefly in mature trees of unknown age. Some of the rings in which it was seen were very narrow ones and might have been formed as the result of lack of moisture in November or December. A ring of this kind is shown in Fig. 1 of Plate xi. It is situated towards the middle of the picture between two larger rings and its outer or brown portion consists of only one or two rows of tracheids with thickened walls. Examination of microtome sections of the small plantation tree of known age from the neighbourhood of Gympie shows that the tangential pitting is exceedingly rare in this specimen. This kind of pitting could not be traced in transverse sections in this instance, although similar sections from mature trees showed it. Only in one or two rings of the small plantation tree could the tangential pitting be traced in radial sections. It would therefore appear that young fast-growing trees of the hoop pine do not develop tangential pitting in the walls of the tracheids of their wood to the same extent as mature trees do.

Summary.

Sections of stems of the hoop pine (*Araucaria Cunninghamii*), bunya pine (*Araucaria Bidwilli*) and Queensland kauri pine (*Agathis robusta*) were examined. All of the sections were obtained from trees growing in localities in which the climate is of a subtropical character. The same degree of distinction and regularity in the growth rings as that which characterizes the wood of many European and North American trees is not shown by the wood of the subtropical specimens of Australian Araucarian conifers.

Of all the sections examined those of the hoop pine showed the greatest regularity in the occurrence of the rings. The boundaries of the growth rings are more sharply defined in old, mature trees than in young, fast-growing ones. The most marked uniformity in the breadth of the rings was observed towards the centre of the sections of the hoop pine from Gympie and Crohamhurst. This circumstance is in accordance with the statement by Antevs to the effect that young, vigorous trees are relatively far less influenced by external conditions than are old individuals.

It appears highly probable that two, three or even more rings may be added to the woody cylinder in one year. Instances may also occur in which rings are omitted or are only imperfectly defined. On the other hand there is evidence to show that in the sections of the hoop pine there are rings in varying numbers, each of which was apparently produced in a single year. Rings of fairly uniform size arranged in connected series in a section of a hoop pine tree from Crohamhurst are assumed to be annual ones. Partial proof of this assumption is given. The radial measurement of the stem of the tree when divided by the mean measurement of the breadth of the assumed annual rings gave a quotient approximating

the known age of the tree. It is suggested that this method could be applied in estimating the age of trees in which a number of fairly uniform rings arranged in series occurs. The method is applied to a section of a hoop pine tree from the neighbourhood of Gympie and part of a section of a Queensland kauri pine tree from Kin Kin and an estimated age for the trees obtained.

The rings in young, fast-growing trees are frequently more readily discernible by the unaided eye in smooth, opaque sections than by microscopic examination of thin, transparent sections. The microscopic features of the growth rings are outlined and illustrated. Bordered pits in the tangential walls of the tracheids are confined to the outer or brown portion of the rings in the hoop pine, bunya pine and Queensland kauri pine. The bordered pits in the tangential walls of the tracheids are much more frequent in the Queensland kauri pine than in the hoop and bunya pines.

Acknowledgments.—The writer is indebted to the Provisional Forestry Board of Queensland and to Mr. Inigo Jones of Crohamhurst for their generous and cordial assistance in the work by providing sections of trees for preparation and examination. Appreciative acknowledgment to Mr. H. W. Mobsby is also expressed for his excellent photograph of the smoothed sections reproduced on Plate x.

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EXPLANATION OF PLATES X-XI.

Plate x illustrates the smoothed parts of sections of the mature hoop pine (*Araucaria Cunninghamii*) from the neighbourhood of Gympie (on left) and of the tree of the same species from Crohamhurst (on right). The entire radius of the stems is shown in each case. The centimetre scale on the right lower side shows the extent of reduction of the illustrations in both cases. The lines drawn into the section on the right indicate roughly the limits of the rings assumed to be annual ones. The section on the right is from a tree 30½ years old. Using the assumed annual rings as a basis of calculation the age of this tree is estimated at 27 years. The actual age of the tree represented on the left is not known, but, using assumed annual rings as a basis, its age is estimated at 135 years.

Plate xi.—In all of the figures the honeycomb-like pattern represents the tracheids in cross section. The dark, narrow, double lines passing from top to bottom of the pictures represent the wood rays. These two tissue elements, tracheids and rays, are the sole constituents of the normal wood of the species of *Araucaria* and *Agathis* which are dealt with.

Figs. 1 and 2 were photographed with a 16 mm. apochromatic objective (N.A., 0·3) and compensating eyepiece 4. Fig. 3 was photographed with a 4 mm. apochromatic objective (N.A., 0·95) and compensating eyepiece 4. The sections were stained with Heidenhain's iron haematoxylon and safranin.

Fig. 1.—Photomicrograph of transverse section of wood of hoop pine (*Araucaria Cunninghamii*). The figure illustrates the three outermost growth rings of the specimen shown on the left of Plate x. The uppermost portion of the figure is turned towards the bark. Three growth rings are shown. The very narrow one towards the middle of the figure might have resulted from a dry early summer, but no proof of this assumption can be given. × 40.

Fig. 2.—Photomicrograph of transverse section of portion of wood of bunya pine (*Araucaria Bidwilli*) from neighbourhood of Gympie. A growth ring is seen towards the middle of the figure. × 40.

Fig. 3.—Photomicrograph of transverse section of portion of wood of Queensland kauri pine (*Agathis robusta*) from Kin Kin. A growth ring is shown obliquely traversing the middle of the figure. The small dark spots on the tangential walls of the thickened tracheids indicate the positions of tangential bordered pits. The two loop-like structures in the radial wall of a tracheid in the upper left side of the figure indicate the positions of two radial bordered pits. The dark band on the left represents a wood ray. × 170.

APPENDIX: *Growth Rings in an Australian Fossil Coniferous Wood.*

Through the courtesy of Mr. H. A. Longman, the writer was able to examine a specimen of a fossil, apparently coniferous wood collected in a cutting in Ann Street, Brisbane. Professor Richards determined the beds, in which the fossil was found, as situated at the base of the Ipswich Coal Measures (Triassic). A hand-specimen of the fossil wood was ground down to a smooth surface on a transverse plane. Examination with a lens showed well-defined tracheids in cross section and rays in longitudinal section. Wood rings are very well marked in the specimen. They vary in width from 1 to 2 mm. and are more regular than the rings in the wood of the present-day Queensland conifers which were examined during the investigation outlined above. The growth rings in the fossil wood in regularity approach those in the wood of many European and North American trees which are contrasted in this particular with the subtropical Australian Araucarian conifers. A small piece of the fossil wood was placed on the stage of a microscope and a connected series of four rings measured with an ocular micrometer. The measurements of the width of the rings obtained in this way were: 1·52, 1·36, 1·6 and 1·6 mm. Viewed from the standpoint of living trees the rings in the fossil wood have the appearance of being annual in character. The regularity of the rings suggests that the climate in Triassic times might have been much more regular in the incidence of seasonal factors, such as rainfall, than the climate of Brisbane at present. If the rings were annual in occurrence it is also indicated that the tree which became fossilized grew at a slower rate than the Araucarian conifers dealt with in the paper above (see section on the occurrence of annual rings in the wood of Australian Araucarian conifers).

In Bulletin No. 7 of the Geological Survey, Department of Mines, Queensland, p. 15, 1898, John Shirley has described a fossil wood under the name of *Araucarioxylon Brisbanense* from the locality "Ann Street, North Brisbane, in street cutting; Gympie Formation, Permo-Carboniferous System". The specimen described by Shirley is evidently from the same beds as the specimen examined by the writer. Shirley's specimen may be from the same species and possibly from the same tree. Our knowledge of the stratigraphy of this locality is now such that we are reasonably certain that the fossil-wood-bearing beds in Ann Street are at the base of the Ipswich Coal Measures (Triassic), and do not belong to the Permo-Carboniferous System.

A REVIEW OF THE AUSTRALIAN SPECIES OF *CORYSANTHES* (ORCHIDACEAE).

By The Rev. H. M. R. Rupp, B.A., and W. H. Nicholls.

(With Plate xii.)

[Read 27th April, 1928.]

For some years one of us (H.M.R.R.) had been unable to reconcile the determinations made in New South Wales, Victoria and Tasmania respectively, of the terrestrial orchid *Corysanthes pruinosa* Cunn. The Victorian *C. pruinosa* appeared to be identical with the Tasmanian *C. diemenica* Lindl.; the Tasmanian *C. pruinosa* was known in Victoria and South Australia as *C. fimbriata* R. Br. Neither agreed with the plants known as *C. pruinosa* and *C. fimbriata* in New South Wales, depicted by Fitzgerald (Australian Orchids, Vol. I, part 1). The suggestion was made that all three were really only variations of one species (*Vict. Nat.*, May, 1926), and as a result of correspondence on the subject between the present authors, both were convinced that the suggestion would not meet the facts. From many other observers in and beyond Victoria and New South Wales we received numerous notes and specimens bearing on the problem. Finally we reached complete agreement in regard to a solution; and as our investigations had involved some study of other forms of *Corysanthes*, we decided to collaborate in a review of all the known Australian species of the genus. Before we submitted the review for publication, we sent the MS. to Dr. R. S. Rogers of Adelaide for his opinion and we feel sure that the fact that our conclusions are endorsed by such an authority will carry weight with all into whose hands this review may come: we desire gratefully to acknowledge some valuable suggestions which Dr. Rogers has made in regard to details. We also wish to acknowledge here the kindness of the following botanists and observers, whose assistance has been of great value to us: Mrs. Edith Coleman, Blackburn, Victoria; Mr. P. F. Morris, Assistant-Government Botanist, Melbourne; Mr. and Mrs. E. Nubling, Sydney; Mr. C. T. White, Government Botanist, Brisbane; Dr. Darnell Smith, Director, Sydney Botanic Gardens; Mr. E. Cheel, Curator, Sydney National Herbarium; Mr. L. Rodway, Government Botanist, Hobart; Mr. A. B. Braine, Murrumbeena, Victoria; Mr. A. J. Tadgell, Melbourne; Mr. G. V. Scammell, Mosman, N.S.W.; Ven. Archdeacon Atkinson, Tasmania; Dr. H. L. Kesteven, Bullahdelah, N.S.W.; Mrs. H. Curtis, Tambourine Mtn., Queensland; Mr. A. G. Hamilton, Chatswood, N.S.W.; Mr. T. S. Hart, Bairnsdale, Victoria; Rev. G. Cox, Mornington, Victoria.

We include one hitherto undescribed species, under the name *C. dilatata*. This plant is no new discovery, but is the form which has been known in Victoria and South Australia as *C. fimbriata*, and in Tasmania as *C. pruinosa*. It is, however, consistently distinct from either Brown's or Cunningham's species, and we believe that with the recognition of its independent specific rank, the confusion we have alluded to will entirely disappear.

In this review we recognize seven valid species of *Corysanthes* for Australia and Tasmania, viz.: (1) *C. fimbriata* R. Br., (2) *C. diemenica* Lindl., (3) *C. pruinosa* Cunn., (4) *C. dilatata* Rupp and Nicholls, (5) *C. undulata* Cunn., (6) *C. bicalcarata* R. Br., (7) *C. unguiculata* R. Br.

It will be noted that we retain Robert Brown's names in preference to those of Salisbury. This matter has been discussed by Mr. E. E. Pescott in the *Victorian Naturalist* for May, 1926.

During a visit to Sydney in July, 1927, the late R. D. Fitzgerald's unpublished plates and drawings were inspected in the Mitchell Library. By the courtesy of the Librarian, Mr. E. Nubling very kindly made careful tracings for our use, of the figures of *Corysanthes Hamiltonii* in this collection. We have also examined the specimens under this name in the Sydney and Melbourne National Herbaria. We have independently arrived at the same conclusion in regard to Fitzgerald's plant—namely, that it is in all essential features identical with Lindley's *C. diemenica.*

Before dealing with the species seriatim, we offer the following remarks on various points of importance:—

1. *Confusion Between Certain Species.*—This is evident at least as far back as Sir J. D. Hooker's time, for in his "Flora Tasmaniae", Vol. II, there is depicted under the name *C. fimbriata* the form since known in Tasmania as *C. pruinosa*, and in this review called *C. dilatata.* In Baron von Mueller's Census of Australian Plants (1889), *C. pruinosa* appears to be given the range of the whole continent except the dry interior and the far north. The only *Corysanthes* specimens in the Melbourne National Herbarium from Western Australia appear to be identical with *Corysanthes fimbriata* or *C. dilatata.* It is, of course, difficult to determine herbarium specimens of *Corysanthes* (except in one or two cases) with absolute certainty, but the western specimens under notice, as far as can be observed, do not agree with Fitzgerald's exposition of *C. pruinosa.* In the Sydney Herbarium, there are three specimens from King George Sound, Western Australia (collected by Lieut.-Col. B. T. Goadby), which perhaps call for further investigation. In the absence of living plants, photographs, or detailed drawings, we recognize the need of caution in determining these western forms: but we cannot regard them as identical with *C. pruinosa* in Fitzgerald's plate. Indeed, it will be seen below that no satisfactory evidence has reached us of the existence of Cunningham's species *C. pruinosa* outside New South Wales. In the 1923 Census of Victorian Plants published by the Field Naturalists' Club, Victoria is credited with four species—*C. unguiculata, C. bicalcarata, C. fimbriata,* and *C. pruinosa.* In correspondence between us it was pointed out that it was impossible to reconcile the Victorian determinations of the last two species with the determinations illustrated by Fitzgerald in New South Wales. The Victorian *C. fimbriata* was regarded as identical with the Tasmanian plant called *C. pruinosa*, but we were not satisfied that the latter corresponded with Fitzgerald's plant. The Victorian *C. pruinosa* was still less like it, and appeared in all respects identical with the Tasmanian *C. diemenica.* The drawings (Plate xii, series 4, 1-9) demonstrate beyond doubt that in the plant hitherto called *C. fimbriata* in Victoria and South Australia, and *C. pruinosa* in Tasmania, we really have a very distinct species, to which the name *C. dilatata* is given. Thus—

C. diemenica Lindl. = the supposed *C. pruinosa* of Victoria and South Australia.

C. dilatata Nicholls = the supposed *C. fimbriata* of Victoria and South Australia, and the supposed *C. pruinosa* of Tasmania.

We consider that Fitzgerald's plate agrees in all essentials with Bauer's type-drawings of Robert Brown's *C. fimbriata* (Atlas of Brown's "Miscellaneous Works", Royal Society, 1868). We also accept Fitzgerald's plate as an accurate representation of the type form of Cunningham's *C. pruinosa*. While we are inclined to believe that evidence points to the occurrence of *C. fimbriata* in all the Australian States, of *C. pruinosa* we have been unable to secure specimens, or to find indisputable records, from any locality except within New South Wales. The curators of the Brisbane and Sydney National Herbaria very kindly sent their *Corysanthes* material for inspection. The specimens labelled *C. pruinosa* from States other than New South Wales were all identical with either *C. diemenica* or the form here called *C. dilatata*. In the Brisbane collection, one specimen, collected by W. Bauerlen in 1890, is identical with the New South Wales *C. pruinosa*, but the locality cannot be identified, and Mr. C. T. White does not think it was in Queensland.

2. *Difficulties of Determination.*—The difficulties have arisen chiefly in connection with *C. fimbriata*, *C. diemenica*, and *C. pruinosa*. The non-recognition of the plant now named *C. dilatata*, as a species quite distinct from either *C. fimbriata* or *C. pruinosa*, and the overlooking by many botanists of the definite character of Lindley's *C. diemenica*, would appear to have been mainly responsible for the difficulties. A comparison of the series 1 to 4 in the figures of Plate xii will show at once how distinct these four species are when examined critically. There is little difficulty in regard to the remaining three species. *C. bicalcarata* and *C. unguiculata* are readily determined from any of the existing descriptions. *C. undulata* will not be found in any existing handbook of Australian flora, because it was apparently never recorded since Cunningham described it in 1833 (New South Wales Magazine, No. 1) until its re-discovery at Bullahdelah (N.S.W.) in 1924. Dr. Rogers reported the circumstances, reprinted Cunningham's description, and added further particulars (*Trans. Roy. Soc. S. Aust.*, Vol. li, 1927). In May, 1927, Dr. H. L. Kesteven of Bullahdelah sent a number of living specimens, from which we are able to supplement Dr. Rogers' notes with other details of this interesting little orchid.

3. *Elongation of Flowering Stem after Fertilization.*—This interesting habit (shared by some species of *Chiloglottis*) is characteristic of our *Corysanthes*. It has commonly been regarded as a device for securing the dispersal of the seeds by wind, but we confess we are not satisfied with this explanation. In the fern-trunk form of *C. dilatata* (see below) there is almost invariably vigorous elongation, and it does not seem possible to apply the wind theory to a plant growing on the trunks of fern-trees in deep, sheltered forest gullies. In August, 1927, one of us (W.H.N.) carefully watched plants of *C. diemenica*, and came to the conclusion that elongation of the stem was dependent upon the moisture supplied to the plants. At the same time, it must be said that the habit requires some further explanation. Colonies of more than one species have been observed, in which some plants had fruiting stems up to 6 inches, and others developed seeds without elongating the stem at all. The habit appears to be strongest and most consistent in *C. undulata* and *C. dilatata*, but is often very pronounced in *C. diemenica*. It is feebly developed in *C. unguiculata* and *C. pruinosa*. Mr. E. Nubling reports finding fruiting plants of *C. fimbriata* near Como, N.S.W., in September, 1927, with stems up to 6 inches. This is the only record of the habit in *C. fimbriata* which we have obtained. As far as we have been able to ascertain,

the habit is very unusual in *C. bicalcarata*: but specimens have been received from Dr. H. L. Kesteven of Bullahdelah, with fruiting stems several inches in length. It is therefore clear that all our Australian species possess the capacity for this interesting habit, the purpose of which seems to call for fuller investigation.

4. *The Leaves of* Corysanthes.—There is close resemblance between the leaves of most of our Australian species. One leaf, close to the ground, is the rule: exceptionally two are found. In *C. undulata*, *C. bicalcarata*, and *C. unguiculata* the leaf is a darker green than in the others, and—particularly in the last two—is often reddish-tinged. In all forms it is usually more or less "frosted" on the under surface. The shape varies from orbicular to ovate or cordate, and in all species there is an occasional tendency to lobation.

5. *Habitat.*—The principal habitat of Australian species of *Corysanthes* is (on the continent) the coastal area. In the eastern States this term specifically denotes the country between the Great Dividing Range and the ocean—a belt varying in width from a few to 60 miles. Some species also occur throughout the ramifications of the Dividing Range itself, and—much less commonly—on the interior slopes. In Tasmania they may be found in most parts of the State, except at high elevations and on open grass-lands. The localities mentioned below (followed by the collector's name or initials) are those from which we have ourselves personally examined either living or herbarium specimens. Specimens from the National Herbaria are indicated.

Notes on the Seven Australian Forms Here Treated as Valid Species.

We offer below a tabulation of the main characteristics distinguishing the four species in regard to which confusion has existed in the past, viz.: *C. fimbriata*, *C. diemenica*, *C. pruinosa*, and *C. dilatata*. In this table it will be noted that reference is not made to (1) the columns, (2) the calli on the labella. Both these features are subject to variation, and it would be difficult to include them satisfactorily in so brief a summary. Typical columns and calli are shown in the series of figures on Plate xii. It will be observed that we do not follow Fitzgerald in making the presence of calli a distinguishing feature of *C. pruinosa* in contrast with *C. fimbriata*. Their presence is perhaps more consistent in the former, but is by no means uncommon in the latter. With regard to the remaining three species, we feel that it is unnecessary to add to the existing descriptions of two such well-defined species as *C. bicalcarata* and *C. unguiculata*; while Dr. Rogers has sufficiently described *C. undulata* in his recent paper referred to above. Our remarks on these species will be restricted, as far as possible, to supplementing information which is already available.

1. Corysanthes fimbriata R. Br. Plate xii, series 1, figs. 1 to 8.

Cf. Bauer and Fitzgerald, in publications referred to above under "Confusion Between Certain Species". If columns 1 and 4 in the table be studied in conjunction with series 1 and 4 of the figures on Plate xii, we think it will be freely admitted that we have here two distinct species. That does not prove that the form to which we have given the name *dilatata* is not really Robert Brown's *C. fimbriata*. It has been so regarded in Victoria and South Australia, and Hooker's plate, already alluded to, may be cited in support. But we submit the following points against this determination: (i) Hooker's decision was evidently not endorsed in Tasmania, where *C. dilatata* has since been generally known as *C. pruinosa*; (ii) Bauer's type-drawings of Brown's species cannot be claimed as

Table of Main Characteristics distinguishing C. fimbriata, C. diemenica, C. pruinosa, *and* C. dilatata.

1. *C. fimbriata* R.Br.	2. *C. diemenica* Lindl.	3. *C. pruinosa* Cunn.	4. *C. dilatata* Rupp and Nicholls.
Dorsal sepal broad-cuneate, dark or with dark spots.	Dorsal sepal similar to that of *C. fimbriata* in outline, but narrower; greyish or sometimes dark.	Dorsal sepal narrow, paddle-shaped, greyish-green, finely spotted.	Dorsal sepal very broad above, narrowing abruptly, always dark reddish-purple.
Flower varying in size, but often the largest of the genus in Australia; very fragile and loosely-set; somewhat depressed, and always close to the leaf.	Flower usually small; compact, firm, and stiffly-set; close to the leaf.	Flower small (with rare exceptions), loosely-set, variable in distance from leaf.	Flower typically rather large (small in the fern-trunk form); firm, erect, and high off the leaf.
Lamina of labellum always considerably longer than the tube; margins dark, slightly incurved, fringed with long dark fimbria.	Lamina of labellum approximately equal to the tube; margins very dark and conspicuously incurved, minutely denticulate	Lamina of labellum shorter than the tube (rarely as long); margins imperfectly veined, hardly incurved, fringed with pale or dark fimbria.	Lamina of labellum conspicuously shorter than the tube; margins widely expanding, prominently veined, coarsely denticulate; the teeth occasionally prolonged near the apex of the lamina into one or two fimbria.
Central boss of labellum imperfectly defined, varying from white to very dark.	Central boss prominent, pure white or with a dusky patch in the middle.	Central boss pale, often with a dusky patch in the middle.	Central boss large and prominent, usually with two small posterior extensions; white or suffused with purple.
Auricles variable, but in most cases large and prominent.	Auricles usually large and prominent.	Auricles with very small apertures, often appearing like mere gibbosities.	Auricles consistently large and prominent.
Sepals and petals more or less appressed, often held back by the lamina of the labellum. Sepals connate to the middle. Petals slightly broader than sepals, typically but not invariably bifid at the tips.	Sepals and petals free behind the lamina of the labellum. Sepals projected forward or erect, slender, entire. Petals usually much shorter and broader, unequally bifid at the tips.	Sepals and petals free below the lamina of the labellum, but often projecting through the fimbria, rather long (sepals often conspicuously so), entire.	Sepals and petals free much below the lamina of the labellum, short and very frequently all bifid at the tips.
Ovary short, slender.	Ovary short, broad.	Ovary short.	Ovary very long.

depicting our *C. dilatata*; (iii) the margins of the labellum in *C. dilatata* cannot be accurately described as fimbriate, they are boldly dentate; (iv) so far as we can ascertain, *C. dilatata* has not been found in Queensland or New South Wales, from both of which *C. fimbriata*, as Fitzgerald shows it, is recorded; (v) the type form of Brown's species undoubtedly came from New South Wales, where Fitzgerald's plant is fairly common, and never approaches *C. dilatata*. These considerations seem sufficient evidence against the identity of *C. dilatata* with Brown's *C. fimbriata*.

The flower of *C. fimbriata* varies in size, but is usually large, and often attains greater dimensions than that of any other Australian species. One specimen measured nearly 3½ cm. As a general rule, the flowering season begins very early—in the Paterson district of N.S.W. it has been found in full bloom at the end of April. Notwithstanding the confusion with *C. dilatata*, there is no doubt that the real *C. fimbriata* occurs in Victoria; the records below are those of plants identical with the N.S.W. form.

Range of Species.—Q'land, N. S. Wales, Vict., Tas.

We are very doubtful whether either Brown's *C. fimbriata* or Cunningham's *C. pruinosa* occurs in Western Australia. We have examined the only Western Australian specimens which were available to us in New South Wales and Victoria—specimens in excellent condition in the Sydney and Melbourne Herbaria. We are of opinion that these specimens are identical, and that they appear to be a form of *C. dilatata* (described below) with a shorter labellum-tube than the type. We do not care to press this determination without having seen living plants, but we are confident that they do not agree with either *C. fimbriata* or *C. pruinosa*.

Localities.—Q'land: Tambourine Mountain, Mrs. H. Curtis (also specimens in Bris. Nat. Herb.); Brisbane River, F. M. Bailey (Bris. Nat. Herb.); Brighton (Bris. Nat. Herb.). N. S. Wales: Paterson, H.M.R.R.; Kurnell, J. L. Boorman (Syd. Nat. Herb.); National Park, E. Nubling; Blue Mountains, G. V. Scammell. Vict.: Bairnsdale, T. S. Hart; Frankston, Mrs. Edith Coleman (in Mr. A. J. Tadgell's herbarium); also specimens in Melb. Nat. Herb. from Sealer's Cove, etc. Tas.: Low Head, H.M.R.R. and Mrs. G. E. Perrin.

2. C. DIEMENICA Lindl. Plate xii, series 2, figs. 1 to 9.

See Rodway's "Flora of Tasmania", p. 196. Mr. Rodway states that he has been disposed to regard *C. diemenica* as "a depauperised form of *C. fimbriata*". The differences between the two, however, appear to be constant, and nothing like an intermediate form has come under our notice. Small flowers of *C. fimbriata* do not indicate any tendency to approach *C. diemenica*, nor do large flowers of the latter bear any greater resemblance to the former. If they were merely variants, one might reasonably expect signs of their identity in the character of the margins of the labellum-lamina. But in *C. fimbriata* these are consistently fringed with the long, loose fimbria which give the species its name: in *C. diemenica* they are always minutely denticulate. Reference to the table will show other important differences. It will be noticed that we have said of *C. diemenica*, "petals in most cases much shorter and broader (than sepals)". In some Tasmanian specimens sent by Archdeacon Atkinson, however, the petals are nearly twice as long as the sepals.

All the Tasmanian specimens of *C. diemenica* which we have seen are undoubtedly identical with the plant which has been known in Victoria and South

Australia as *C. pruinosa*. Unfortunately none of Cunningham's specimens are available for reference; but we think that the following points supporting the recognition of this orchid as *C. diemenica* will be found convincing: (i) It differs constantly in many details (see table) from the New South Wales *C. pruinosa* as depicted by Fitzgerald (Vol. I, part 1); (ii) it agrees well with Lindley's *C. diemenica*, and is beyond doubt identical with the Tasmanian plant known by that name; (iii) the type form of *C. pruinosa* came from New South Wales. If, as we believe (see above, p. 81), Fitzgerald's *C. Hamiltonii* is identical with the plant under discussion, it is obvious that Fitzgerald did not recognize this plant as *C. pruinosa*; (iv) Cunningham's description of his species ("New South Wales Magazine", No. 1, 1833) distinctly states of the labellum-lamina, "marginibus fimbriatis". It is surely not possible to call them fimbriate in *C. diemenica*.

Range of Species.—N. S. Wales (*C. Hamiltonii* Fitzg.), Vict., Tas., S. Aust. (In N. S. Wales the plant is apparently rarely met with.)

Localities.—N. S. Wales: Guntawang, A. G. Hamilton (in Syd. Nat. Herb.). Vict.: Cheltenham, Oakleigh, and Lockwood, A. B. Braine; Healesville, Mrs. Edith Coleman; Wattle Glen, D. Matthews; Sandringham, A. J. Tadgell (incl. a specimen with 2 flowers); Mentone, etc., W.H.N.; Bairnsdale, T. S. Hart; Mornington, Rev. G. Cox; Lara, Rev. A. C. F. Gates; Glenelg River, C. Walter (in Syd. Nat. Herb.). Tas.: Penguin, etc., Archdeacon Atkinson; Hobart, Granton, Launceston, and Low Head, H.M.R.R.

(In Syd. Nat. Herb. there are specimens labelled "*C. fimbriata* var. *diemenica*" which are undoubtedly identical with the species described in this review as *C. dilatata* Rupp and Nicholls).

3. C. PRUINOSA Cunn. Plate xii, series 3, figs. 1 to 7.

See also Fitzgerald, Vol. I, part 1. Cunningham's original description of this species is referred to above under *C. diemenica*, and is quoted by Dr. Rogers (*Trans. Roy. Soc. S. Aust.*, li, 1927). There is a strong likeness between this and *C. fimbriata*. In the distinctions emphasized by Fitzgerald, there are two which should probably be omitted: (1) the calli on the labellum, which really occur in both species, (2) the distance of the flower from the leaf. *C. pruinosa* is very variable in this respect, though *C. fimbriata* is more consistently "squat". The main points of difference are set out in the table above. The dorsal sepal is perhaps one of the outstanding features distinguishing the two. In *C. fimbriata* it has the form of a broad wedge, and is frequently dark reddish-purple; when not so, it is of a peculiar greenish tint, with large dark spots. In *C. pruinosa* it is narrow, and in outline shaped like a paddle. The colour is usually greyish, with darker spots. In two specimens sent by Mr. E. Nubling from the N.S.W. National Park, the dorsal sepal is extraordinarily long, curving over the rest of the flower like the galea in some forms of *Pterostylis*.

We have already mentioned our inability to obtain any definite and indisputable records of *C. pruinosa* from localities outside New South Wales. The veteran botanist, Mr. A. G. Hamilton, wrote to say that he believed he had seen a form agreeing with Fitzgerald's figures at the Werribee Gorge in Victoria. One of us (W.H.N.) made a special trip to the locality, and after much difficulty succeeded in finding one or two "colonies"—without a single flower. Descriptions and sketches furnished by Mr. Brittlebank, who lives near by, convinced him that these plants are identical with *C. dilatata*, and not with the N.S.W. *C. pruinosa*. It is most difficult to believe that this species is really confined to New South

Wales. It is so abundant there, over such a large area, that it seems probable it will yet be found in the adjoining States.

Range of Species.—New South Wales. (One specimen from an unknown locality, which may not be in N.S.W., is in Bris. Nat. Herb.)

Localities.—Lane Cove, Parramatta River, Lilyvale, Narrabeen, Hawkesbury R., Bullahdelah, and Paterson, H.M.R.R.; National Park, E. Nubling and G. V. Scammell; Blue Mountains, G. V. Scammell.

4. C. DILATATA, n. sp. Plate xii, series 4, figs. 1 to 9; and series 5, fig. 1.

See also figures in Hooker's "Flora Tasmaniae", Vol. II; and in Dr. Rogers' "South Australian Orchids", p. 20; in both instances under the name *C. fimbriata.*

Labello ecalcarato, infra cucullato, supra dilatato; disco glabro; marginibus dilatatis, dentatis; galea basi attenuata, erecta, curvata, apice obtusa aut mucronata.

Plant slender, about 2½-3 cm. high above the leaf. Flower in the typical form rather large standing erect from the leaf above a long ovary of about 7 mm. Leaf of variable size and shape, commonly orbicular-cordate, with a tendency to lobation, green, frosty beneath. Dorsal sepal very broad and low-set, concave; lower portion erect, then curved, the apex projecting over and beyond the lamina of the labellum; width at broadest part about 1½ cm.; colour dark reddish-purple over pale green. Lamina of labellum always shorter than the tube, often much so; margins widely expanding at maturity, boldly and coarsely toothed. Veins between margins and central boss irregularly blotched, prominent, purplish, ending at the apices of the teeth. Central boss large and conspicuous, whitish except in two forms referred to below, almost circular, but usually with two posterior ear-shaped extensions; calli round the base red, acuminate. Auricles very conspicuous, translucent, with two purplish-red marks above them; openings much dilated, facing downwards and forwards, most frequently much below the lamina. Beneath them are the sepals (5 mm.) and the petals (2-3 mm.) projecting forward, all frequently with bifid tips and purplish markings. Column about 2 mm., not conspicuously winged. Stem often elongated after fertilization, occasionally attaining 25 cm. in height. Fl. July to early September.

Mrs. Edith Coleman has drawn our attention to the variations between the type form of this orchid and that which is found growing on the trunks of fern-trees in Victorian forest gullies. The flower is always smaller than the type, and is usually thrown back from the leaf by the curving of the pedicel. This is probably due to the perpendicular attitude of the fern-trunk. The central boss is suffused with purple. The sepals often appear connate, but a touch will separate them. Archdeacon Atkinson sent specimens of the type form from N.W. Tasmania with large flowers of very dark colour, in which the central boss was suffused with purple as in the little fern-trunk form.

The differences between this plant and the two species with which it has been confused—*C. fimbriata* and *C. pruinosa*—will be readily appreciated if series 1, 3, and 4 of figures on Plate xii be compared. The outline of the dorsal sepal of *C. dilatata* is almost flabellate, the contraction of the broad hood being very abrupt. The flower is strikingly erect and firmly set, in contrast with the depressed attitude of both the other species—even when the flower of *C. pruinosa* is well off the leaf it has nothing of the upright, "military" aspect of *C. dilatata.* The widely-expanding dentate margins of the lamina in the latter also give it a very

distinctive appearance. The auricles, sepals, and petals are not concealed as in the others, and the ovary is relatively very long.

Range of Species.—Vict., Tas., S. Aust.

Localities.—Vict.: Lockwood, A. B. Braine; Hawkesdale, H. B. Williamson (in Syd. Nat. Herb., labelled *C. pruinosa*); Healesville, Mrs. Edith Coleman; Sherbrooke and Lorne, W.H.N.; Fern Tree Gully, F. J. Bishop; Gembrook, D. Matthews; Olinda, A. J. Tadgell. Tas.: Penguin, Archdeacon Atkinson; Hobart, Relbia, Launceston and Low Head, H.M.R.R. S. Aust.: National Park, Dr. R. S. Rogers (in Syd. and Bris. Nat. Herb., labelled *C. pruinosa*).

5. C. UNDULATA Cunn. Plate xii, series 5, figs. 2 to 9.

The re-discovery of this diminutive species by one of the present writers at Bullahdelah, N.S.W., in 1924, after its disappearance from botanical records for over 90 years, has been mentioned (*Vict. Nat.*, May, 1926), and reported more fully by Dr. Rogers (*Trans. Roy. Soc. S. Aust.*, li, 1927). Specimens received in 1927 from Dr. H. L. Kesteven of Bullahdelah have enabled us to supply some further details of interest. The dorsal sepal is very conspicuously reticulate-veined. The lamina of the labellum is almost circular in appearance, but has a prominently mucronate apex; and the whole of its anterior upper surface is thickly studded with calli of two forms. The margins are very minutely denticulate, with occasional groups of very slender, short, dark fimbria; their general contour is irregularly undulate. The labellum-tube has a remarkable protuberance directly under the base of the lamina. It is quite as definitely bicalcarate as the tube of *C. bicalcarata*, but the spurs are relatively shorter. Immediately above each spur there is a small perforation in the tube. In most specimens the petals are almost abortive. The flowering stem is conspicuously elongated after fertilization.

C. undulata occurs on the lower slopes of the Alum Mountain close to the township of Bullahdelah, favouring moist clay or poor soil in scrubs of *Melaleuca nodosa*.

Range of Species.—N. S. Wales.

Locality.—Bullahdelah, H.M.R.R. and Dr. H. L. Kesteven.

6. C. BICALCARATA R. Br. Plate xii, series 6, figs. 3, 4, 8, 9.

See also Fitzgerald, Vol. I, part 2. Our figures illustrate considerable variation in the dimensions of the spurs. The unique form of this orchid renders it very easy of identification, and it is unnecessary to add to the descriptions already available. In Victoria and Tasmania *C. bicalcarata* is regarded as one of the smaller species, but in northern N. S. Wales and in Queensland it sometimes rivals *C. fimbriata* in size. It is, however, variable in this respect; among the smallest specimens we have seen are three collected by the late E. J. Banfield on Dunk Island, off the coast of North Queensland. These are in the Brisbane National Herbarium. At Bullahdelah a very large white-flowering form was found earlier than the type. A specimen of this form from the Pine River, north of Brisbane, is in the Brisbane collection, and Mrs. H. Curtis records it from Tambourine Mountain.

Range of Species.—Q'land, N. S. Wales, Vict., Tas.

Localities.—Q'land: Tambourine Mountain, Mrs. H. Curtis; Brisbane River, F. M. Bailey; Pine River, — Stutter; Ravenshoe, Miss Blakeney; Dunk Island, E. J. Banfield (last four in Bris. Nat. Herb.). N. S. Wales: Hornsby, W. F. Blakely (in Syd. Nat. Herb.); National Park, E. Nubling; Blue Mountains, G. V. Scammell;

Bullahdelah and Paterson, H.M.R.R. Vict.: Healesville, Mrs. Edith Coleman. Tas.: Eaglehawk Neck, Archdeacon Atkinson.

7. C. UNGUICULATA R. Br. Plate xii, series 6, figs. 1, 2, 5, 6, 7.

See also Fitzgerald, Vol. I, part 2. This dainty little flower is easily identified, and requires but brief comment here. For an excellent exhaustive description, see Dr. Rogers' "South Australian Orchids", p. 18. The re-discovery of *C. undulata* probably deprives *C. unguiculata* of the distinction of being the smallest Australian *Corysanthes*. We have not come across any reference to the very remarkable arrangement of calli in this species; seen under a magnifier the glistening array is quite unique. *C. unguiculata* has an extensive range, but is sparsely distributed and by no means common.

Range of Species.—N. S. Wales, Vict., Tas., S. Aust.

Localities.—N. S. Wales: National Park, E. Nubling; Kurnell, J. L. Boorman (in Syd. Nat. Herb.). Vict.: Oakleigh, A. B. Braine and W.H.N.; Healesville and Wilson's Promontory (with elongated stems), Mrs. Edith Coleman; "Port Phillip", C. French, jun. per F.v.M. (in Bris. Nat. Herb.). Tas.: Lindisfarne, H.M.R.R.

List of Authorities Consulted.—Robert Brown, *Prodromus Florae Novae Hollandiae*, and *Botanical Atlas.* Hooker, *Flora Tasmaniae* and *Icones Plantarum.* Lindley, *Genera and Species of Orchids. New South Wales Magazine*, No. 1, 1833. Paxton, *Botanical Dictionary.* Bentham and Mueller, *Flora Australiensis*, Vol. VI. Fitzgerald, *Australian Orchids.* Mueller, *Census of Australian Plants*, 1889, and *Key to the System of Victorian Plants.* Dr. R. S. Rogers, *South Australian Orchids.* Bailey, *Queensland Flora.* Moore and Betche, *Handbook of the Flora of N.S.W.* Rodway, *Flora of Tasmania.* Victorian F.N.C. Census of Victorian Plants, 1923.

EXPLANATION OF PLATE XII.

Series 1. *C. fimbriata* R. Br.—1, side view; 2, front view (N.S.W. specimens); 3, labellum from front (Victoria); 4, calli from margin below boss; 5, ovary, column, sepals and petals; 6, large auricles; 7, small auricles; 8, dorsal sepal. (In this and the corresponding figures in other series, the dorsal sepal is drawn from above, flattened out to show its contour.)

Series 2. *C. diemenica* Lindl.—1, side view (Victoria); 2, front view (Tasmania); 3, a slender Victorian form*; 4, labellum from front, with conspicuously inturned margins; 5, calli from margin below boss; 6, column, sepals and petals; 7, ovary, sepals and petals of a Tasmanian form with long upright petals, covering auricles; 8, dorsal sepal; 9, acute apex often seen in dorsal sepal.

* This slender form seems to us to agree in practically all respects with *C. Hamiltonii* Fitzg.

Series 3. *C. pruinosa* Cunn.—(All N.S.W.). 1, side view, erect form; 2, front view, depressed form; 3, labellum from front; 4, calli from margin below boss; 5, ovary, column, sepals and petals; 6, auricles, with sepals and petals covering the small orifices; 7, dorsal sepal.

Series 4. *C. dilatata* Rupp and Nicholls.—(Victoria). 1, small fern-trunk form, front view; 2, type form, front view; 3, labellum from front; 4, calli from margin below boss; 5, column, sepals and petals; 6, ovary, auricles, sepals and petals; 7, dorsal sepal; 8, 9, variations in apex of dorsal sepal.

Series 5. *C. dilatata* Rupp and Nicholls and *C. undulata* Cunn.—1, Tasmanian *C. dilatata*, side view; 2 to 9, *C. undulata* (N.S.W.); 2, front view; 3, side view; 4, labellum from front; 5, calli from margin below boss; 6, column from side, with sepals, and showing almost abortive petal; 7, apex of spur from below; 8, ovary, spurs, sepals, and minute orifices in tube; 9, dorsal sepal.

Series 6. *C. unguiculata* R. Br. and *C. bicalcarata* R. Br.—1, 2, 5, 6, 7, *C. unguiculata* (Victoria). 1, side view; 2, front view; 5, ovary, column, sepals and petals, from side; 6, column from front; 7, part of labellum, showing calli (single callus below); 3, 4, 8, 9, *C. bicalcarata*; 3, front view (Victoria); 4, side view (N.S.W.); 8, labellum from front, with spurs, sepals, and ovary below; 9, column from front, with sepals and petals.

All figures are two-thirds natural size, except No. 1 of Series 4, which is approximately one-third natural size.

A REVISION OF THE AUSTRALIAN BOMBYLIIDAE (DIPTERA). Part i.

By Frederick H. S. Roberts, M.Sc.

(Four Text-figures.)

[Read 27th April, 1928.]

Introduction.

The Bombyliidae form a family with well defined limits within the superfamily Asiloidea. While the family has been extensively studied in other parts of the world, in Africa by Bezzi, in India by Brunetti, in Europe by Becker, and in America by Williston and Aldrich, little has been done towards a systematic study of the Australian species. White, in 1916, published descriptions of species occurring in Tasmania, and Hardy in 1921 compiled a catalogue in which he recorded synonyms and made an attempt to place all the described species into definite generic conceptions. In 1923 Hardy published a further paper containing keys found in the unpublished manuscript of White, adding his own notes thereto. These three papers represent the work so far accomplished in arranging the Australian species, and they form a very valuable basis for progressive study.

The original descriptions are to be found in the works of Fabricius, Macquart, Walker, Schiner, Gray, v.d. Wulp, Thomson, Macleay, White and Hardy. Many of the original descriptions given by the earlier authors were based on rubbed or otherwise damaged specimens, making the identification of species somewhat difficult. Until the types, especially of Macquart and Walker, are made available for study, it will always remain doubtful whether the recent identifications made on personal opinions are correct. Most of the specific differences, especially in the larger genera, depend upon colours and pubescence that are easily rubbed off. In specimens that become rubbed, many of the characters are thus destroyed, and the determination of any but good specimens is very difficult, if not impossible. I have endeavoured to find specific differences which do not depend upon colours, but have rarely been successful. I have seen specimens of species that are undoubtedly new that are not yet included in these studies, as either their condition is too poor to warrant a description or too few specimens are available for the purpose.

The material examined consisted of the entire collections of the Queensland Museum, Brisbane; the Australian and Macleay Museums, Sydney; the South Australian Museum, Adelaide; and the Department of Agriculture, Perth. To the authorities of these institutions I wish to express my very grateful thanks. I am also indebted to Mr. G. H. Hardy for the loan of his collection of the family, and for valuable suggestions and advice; to Dr. I. M. Mackerras, the late Dr. E. W. Ferguson, and Messrs. Nicholson, Dodd, Mann, and Smith, for the opportunity afforded to examine their material. I must also thank Major E. Austin of the British Museum, the Director of the South African Museum, and Dr. J. M. Aldrich, of the United States National Museum, Washington, for their kindness in acceding to my requests for exotic material that has enabled me to place certain species in their genera with more certainty than could otherwise have been done.

Family **Bombyliidae.**

The head is large, generally as broad as the thorax, sometimes much more so, usually globular or semicircular in shape; the eyes are bare, either separated in both sexes, but wider apart in the female, or contiguous in the male and separated in the female, or contiguous in both sexes; the frons is usually raised between the eyes to be moderately convex, rarely concave; the face, in profile, varies from being sharply convex to retreating, both the face and frons being usually covered with pubescence, rarely bare; the occiput is inflated, bilobate above and with a central cavity, or flattened or concave, not bilobate and without a central cavity; the hind borders of the eyes may be indented and the upper and larger facets may be separated from the lower and smaller facets by a distinct line, called the bisecting line; the ocelli are three in number and are placed in a triangle on a usually prominent tubercle at or close to the head vertex; the antennae are composed of three segments, are porrect, and sometimes much longer than the head; they may arise well apart from each other or may be almost contiguous; the third segment is usually furnished with an apical or subapical spine, an elongate and bristle-like style, or an apical pencil of hairs; the style is either one or two jointed; the proboscis may be short and stout, or very elongate and slender, with soft fleshy labella; the palpi are usually slender, composed of one or two segments.

The thorax is more or less quadrate, broadest behind, flattened or humped, usually provided with pre-sutural, pre- and post-alar bristles, and generally covered with dense hairs and scales, sometimes with scales only, but is very rarely bare; the scutellum is large, semicircular in shape, depressed, and usually furnished with bristles, which are more conspicuous along the hind margin; the squamae are large and frequently fringed with scales or hairs; the halteres are slender and of no great length.

The abdomen consists of six to nine visible segments and is of varying shape, curvature and thickness; it may be flattened and more or less straight sided (*Villa*), oval or rotund (*Bombylius*), decumbent and tubular (*Toxophora*), or very elongate and pedunculate (*Systropus*); it is generally clothed with long hairs and scales, or it may be entirely covered with scales only; the male genitalia are generally hidden, and sometimes set on one side; the genitalia of the female may bear at the apex short blunt spines or dense long hairs.

The legs are usually slender, with the front pair abbreviated and the hind pair very long (in the Systropinae they are exceptionally long and strong); the fore legs may be provided with hairs only, or with rather weak spines, which become somewhat more numerous and stronger on the middle and hind legs; the ungues are rather small and may sometimes possess a basal tooth; pulvilli are generally present, but are absent in the Australian species of the Exoprosopinae, and in some of the genera of the Cylleniinae.

The wings have a characteristic reduced venation, as M never has more than three branches in the Australian species. The median cell is usually closed, but is open in two genera, *Pachyneres* and *Cyrtomorpha*; cell Cu and cell R_5 may be open or closed; cells M_1, 2nd M_2 and M_4 are always open; R_{2+3} may originate from R_{4+5} at right angles and close to the vein r-m, or else at an acute angle and at a distance from r-m; R_{2+3} is generally looped at its apex, the loop being strongly developed in some of the Lomatiinae and Cylleniinae; R_4 is also usually curved, but is generally straight in the Phthiriinae, and in the Cyrtosiinae is missing; the axillary lobe and alula are usually well developed, but in the genera *Docidomyia*

and *Systropus* the lobe is considerably reduced and the alula is entirely wanting. The wings are not usually hyaline, but of various shades and patterns of brown.

The Adult.—The adults are all sun-loving flies, usually found in the vicinity of flowers and sometimes rank vegetation. Some are to be found only in more or less arid country, and are flies of low, swift flight, hovering over sandy patches of soil, and frequenting the flowers of low growing shrubs and weeds. Others hover in mid air, the rapid vibrations of the wings producing the humming sound, so characteristic of bees. While still on the wing, these flies are enabled to suck the nectar from the flowers by the aid of their long proboscides. In general, the adults of this family are prettily and delicately marked in various shades of yellow and brown. In some localities they may be seen from mid winter (southern Queensland) to the end of April (north Queensland), but are most abundant from early spring to mid summer.

The Larva.—The following quotations are taken from Brunetti: "amphineustic, cylindrical, rather flattened, thirteen segmented; an obvious though small retractile head, with well developed mouth parts, papillate antennae, and no eyes; the young larva is elongate, and each thoracic segment is provided with a pair of long setae, the penultimate segment with two spiracles; the adult larva is obese, and free from setae".

The Pupa.—"Pupa free, mummy like, with strong spines on the anterior part; abdominal segments with chitinous hooklets. Pupa has pro-thoracic and seven pairs of abdominal spiracles, some species bearing transverse rows of spines on most of the segments".

Life Histories.—Little is known of the life histories of the Australian species, and the addition in this paper of some of the life histories of exotic species may help in elucidating the larval habits of some of our species at a subsequent time. The genus *Hyperalonia* has been recorded as a parasite of a scolid wasp which is parasitic on Scarabaeidae (cane grubs), and also of the larva of an Asilid which also is predaceous on cane grubs. *Villa* has been bred from moths of the family Noctuidae, and *Anthrax* is parasitic on solitary mud building wasps, and also on bees.

A species of *Exoprosopa* occurs in North America as a hyperparasite of the Hymenopteron genus *Tiphia*, which is itself parasitic on the Lamellicorn genus *Lachnosterna*. Species of *Villa* have been bred from Lepidopterous and Hymenopterous larvae and from the egg masses of locusts in Europe and North America; of *Anthrax* from solitary and social Hymenoptera; of *Bombylius* from the nests of small bees, *Andrena*, *Halictus*, etc.; of *Systoechus* from the egg masses of locusts; of *Toxophora* from the nests of the solitary wasps, *Odynerus*, *Pelopoeus*, and *Eumenes*; of *Geron* from the larvae of Lepidoptera. *Systropus* has been recorded in several countries as being a parasite of the family Limacodidae.

The recording of the genera *Bombylius* and *Toxophora* as parasitic on Hymenoptera is very interesting as suggested cases of mimicry. At first sight many Bombyliinae are very similar to bees, as instanced by their popular name "bee flies". The yellow and black *Toxophora* is very similar to some of the yellow and black wasps and is somewhat reminiscent of the Syrphid genus *Cerioides*.

Classification.—The Bombyliidae have been regarded as forming one main branch of the superfamily Asiloidea, the Asilidae, Apioceridae, Therevidae, Mydaidae, and Scenopinidae, the other branch. Linnaeus was the first to recognize the family as a definite conception, when, in his "Systema Naturae", he placed all those species known to him in his genus *Bombylius*, leaving the remaining species

in the great genus *Musca*. Scopoli shortly afterwards placed all the latter species in the genus *Anthrax*. These two huge groups, the Bombyliinae and Anthracinae, remained till 1808 when Schiner divided the family into four subfamilies, the Anthracinae, Bombyliinae, Lomatiinae, and Toxophorinae. Another subfamily, the Systropinae, was added by Weidemann a short time after. In 1913 Thomas Becker revised the genera of the world, and brought forward a classification in which the family had been divided into fifteen distinct groups. Becker's main character for these divisions was the positions of the veins R_{2+3}, R_{4+5}, and r-m. Professor Bezzi, in his work "The Bombyliidae of the Ethiopian Region", reduced the number of subfamilies to thirteen. Bezzi, in this classification, places primary importance on the characters of the eyes. Those genera with simple eyes, i.e. eyes in which the hind border is entire and without an indentation, are placed in the Bombyliidae Homeophthalmae, and those in which the hind border of the eyes is indented in the Bombyliidae Tomophthalmae. The former group comprises what he considers the most ancient forms, mostly of Old World origin. These two groups are divided into thirteen subfamilies, viz., Exoprosopinae, Anthracinae, Bombyliinae, Lomatiinae, Toxophorinae, Cylleniinae, Usiinae, Phthiriinae, Cyrtosiinae, Mariobezzinae, Heterotropinae, Cytheriinae, and Systropinae. All these groups, except the Mariobezzinae, Heterotropinae, and Usiinae, are represented in the Australian region by various genera. This classification appears to be satisfactory in so far as the Australian genera of the subfamilies Exoprosopinae, Bombyliinae, Anthracinae, Lomatiinae, Systropinae, and Toxophorinae are concerned. The other three subfamilies, the Phthiriinae, Cylleniinae and Cyrtosiinae, are composed of a heterogeneous collection of genera allied in their respective groups by almost minor characters. For instance, in the Cyrtosiinae we have two genera, *Cyrtomorpha* and *Pachyneres*, which are of a totally dissimilar appearance, allied mainly by the absence of the vein R_4. *Cyrtomorpha* resembles the genus *Bombylius* in general appearance, and *Pachyneres* approaches the Empidae. I am not yet in a position to attempt a reclassification, but it seems to me that an examination of the genitalia, especially of the female, might lead to a more natural division of the family, and in this matter I am collaborating with Mr. G. H. Hardy, whose interests lie mostly in the phylogenetic conceptions to be gained therefrom.

Key to the Subfamilies.

1. Hind border of the eyes with a distinct indentation; eyes with a bisecting line 2
   Hind border of the eyes entire; eyes without a bisecting line 4
2. R_{2+3} originates from R_{4+5} at right angles and close to the vein r-m 3
   R_{2+3} originates from R_{4+5} at an acute angle and distant from the vein r-m ..... Lomatiinae
3. Third segment of antennae with an apical pencil of hairs; pulvilli present ..... Anthracinae
   Third segment of antennae with a minute spine or an elongate and distinct style; pulvilli absent ..... Exoprosopinae
4. Occiput raised, bilobate above and with a central cavity ..... Cylleniinae
   Occiput not raised, not bilobate above and devoid of a central cavity 5
5. R_4 missing ..... Cyrtosiinae
   R_4 present 6
6. Abdomen elongate and pedunculate; metasternum exceedingly developed; hind legs extremely long and strong; wings without an alula and with a diminished lobe ..... Systropinae

   Abdomen not especially elongate and never pedunculate; metasternum normal; hind legs sometimes long but never very strong; wings with alula present; lobe well developed 7

7. Prothorax well developed and beset with strong curved spines; M with only two branches; body covered mainly with scales; legs very stout ..... Toxophorinae
Prothorax normal and never beset with strong curved spines; M with three branches (except in *Geron*); body covered with numerous hairs and scales; legs slender 8
8. Tibiae armed with distinct rows of bristles; body bristly; R_4 usually curved; palpi one-jointed; abdomen oval or rotund ..... Bombyliinae
Tibiae devoid of bristles arranged in rows; if bristles are sometimes present then the palpi are two jointed; body never bristly; R_4 usually straight ..... Phthiriinae

This key is an abstract of that given by the late Professor Bezzi.

Note.—Bezzi has placed the two genera, *Eclimus* and *Marmasoma* in the Cylleniinae. The occiput is certainly raised in both genera, and bilobate in *Eclimus*, but in *Marmasoma* no bilobation is visible and neither genus possesses a central cavity that can be seen.

Subfamily Exoprosopinae.

The head is large and globular. The occiput is raised, bilobate above, and with a central cavity. The eyes are separated in both sexes, and have a long and distinct bisecting line. The frons at the vertex of the head is of varying widths in the males. The antennae are short, well apart at the base, with an elongate and somewhat conical third joint which may be furnished with an apical spine or a long and distinct bristle-like style. The abdomen is large and covered with long hairs and scales, generally in the form of bands. The genitalia of the female are armed with a circlet of bristly spines. The legs are slender, with the fore pair abbreviated and the hind pair rather long. There are no pulvilli in the Australian species. The wings are strong, with a well developed lobe and alula. R_{2+3} originates from R_{4+5} at right angles and close to r-m. Cells Cu and R_5 are sometimes closed.

Five genera fall into this subfamily, *Hyperalonia*, *Exoprosopa*, *Villa*, *Lepidanthrax*, and *Pseudopenthes*. Those species previously recorded in the genus *Anthrax* are now placed in the genera *Villa* and *Pseudopenthes*. The genotype of Scopoli's genus, *Anthrax*, has been shown to possess a pencil of hairs at the apex of the third antennal joint. Scopoli even stated this in his description of the genus, but some confusion had arisen, so that those species possessing such a pencil of hairs at the apex of the third antennal joint had been placed in the genus *Argyramoeba*, while those species possessing at most a minute spine at the apex of the antennae had been erroneously recorded under the name *Anthrax*.

In the genus *Lepidanthrax* I have placed those species catalogued by Hardy as belonging to the genus *Cytherea*, a genus which is more closely related to *Bombylius* than to *Villa*. It differs from *Bombylius* in having a vestiture consisting mainly of scales, and antennae which are widely separated at their base.

Key to the Genera of the Exoprosopinae.

1. Third antennal joint with a long and distinct style 2
Third antennal joint at most with a minute spine 3
2. The cell R_3 only, divided by a crossvein ..... *Exoprosopa* Macquart
The cells R_3 and R_4 each divided by a crossvein ..... *Hyperalonia* Rondani
3. Proboscis well exceeding in length the oral aperture .... *Lepidanthrax* Osten-Sacken
Proboscis at most slightly exceeding in length the oral aperture 4
4. Ocelli placed somewhat below the vertex of the head; claws of posterior tarsi with a long and acute basal tooth; cell 2nd M_2 long and narrow .. *Pseudopenthes*, n. gen.
Ocelli placed at the vertex of the head; claws of posterior tarsi devoid of a basal tooth; cell 2nd M_2 not long and narrow ..... *Villa* Lioy.

Genus Hyperalonia Rondani.

Hyperalonia, Rondani, Archiv. per la Zool., iii, p. 58, 1863; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 44; 1923, 73.

Genotype, *Anthrax erythrocephala*, by original designation.

The head is globular and as broad as the thorax; the frons is very broad at the vertex in the male and not very noticeably broader in the female; the ocellar tubercle is rounded, prominent, and placed somewhat below the vertex of the head; the face is sharply prominent and is covered with hairs and scales; the antennae are rather strong, with a cylindrical first joint, a globular second, about half the length of the first, and an elongate, conical, third joint which bears a long and distinct bristle-like style at the apex; the proboscis is stout, generally slightly longer than the oral opening; the palpi are slender and one-jointed.

The thorax is quadrate, rather flattened, with rounded corners and is furnished with well developed pre- and post-alar bristles, situated on the humeral and post-alar calli, the bristles on the latter being generally 5-8 in number, long, and directed backwards; the scutellum is broad and semicircular and bears long, convergent bristles on its margin; the squamae are large with a fringe of long coloured scales; the halteres are slender.

The abdomen consists of seven segments, is rather broad, flattened below and convex above, generally curved and covered with scales and long hairs, the latter being particularly dense along the lateral margins; the male genitalia are not conspicuous and are set on one side; the genitalia of the female are armed with a circlet of short, blunt spines. The legs are slender, with the fore tibiae devoid of spines, and the tarsal claw usually provided with a short and obtuse basal tooth. The wings are strong with the typical venation of the Exoprosopinae; cells R_3 and R_4 are each divided by a crossvein; the cells R_5 and Cu may be open or closed at the wing border.

Range.—South Europe, Asia, North and South America, North and South Africa, and Australia.

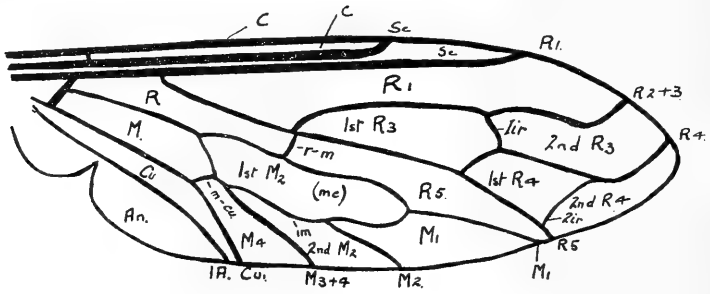
The character of the short and obtuse basal tooth on the tarsal claw is cited by Bezzi as a definite generic character. All the species examined have the basal tooth short and obtuse except a new species, *H. dentata*. This species possesses a basal tooth which is long and acute, like that found in *Exoprosopa*. Brunetti also noticed that this character was not constant for the genus among the Indian species. It appears, therefore, that the separation of *Hyperalonia* and *Exoprosopa* relies on the number of interradials in the cells R_3 and R_4. This character I have found to be vary reliable, which appears inconsistent with the amount of variation usual in the venation in the subfamily.

Australia is not very rich in species of *Hyperalonia*, only eleven species being so far known, of which nine are recorded, four being new. The other two species are represented by specimens in too bad condition for description. One is in the collection of the Macleay Museum, and the other is represented by two specimens in the South Australian Museum.

They are all large, thickset flies of similar appearance, frequenting sandy country, and are usually seen flying very low and close to the ground. *H. satyrus* Fabr. has been recorded as a hyperparasite of the scolid wasp, *Campsomeris radula*, and is also parasitic on the larva of an Asilid. Both the hosts feed on the grubs of Scarabaeidae attacking sugar cane. As the genitalia of the female in this genus are provided with a circlet of blunt spines, the species are probably all parasitic on other insects which pass some stage of their life histories below the surface of the ground.

Distribution.—The genus is widespread over the whole of the continent but is unknown from Tasmania. Two extralimital species occur, *satyrus* and *doryca*,

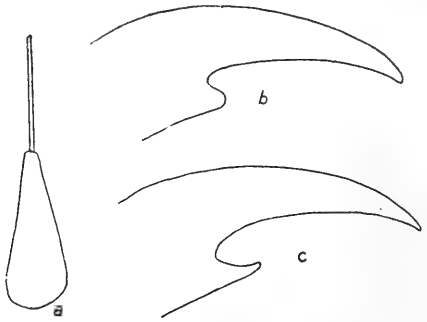
the former extending from New Guinea along the eastern coast, and the latter from the Solomon Islands to Piper's Flats in New South Wales; *septentrionis* and *hemifusca* are only known from the extreme north, and will probably be found to occur outside Australia at some future date. Both *bombyliformis* and *sinuatifascia* are widely distributed, though the latter has not been recorded further north than Cairns; *cingulata* is known from the Swan River (W.A.) to Biniguy, north-west N. S. Wales; *inquinita* and *dentata* are from Queensland and Victoria respectively.



Text-fig. 1. Wing of *Hyperalonia*.

Key to the Species of Hyperalonia.

1. Wings spotted ..... *bombyliformis* Macleay
   Wings not spotted 2
2. Species covered almost entirely with yellow tomentum ..... *dentata*, n. sp.
   Species not covered entirely with yellow tomentum 3
3. Sixth and apical segments of abdomen with white scales 4
   Sixth and apical segments of abdomen with brown scales ..... *hemifusca*, n. sp.
4. Apical segments of abdomen with isolated spots of white scales 5
   Apical segments of abdomen covered entirely with white scales 7
5. Abdomen with yellowish hairs on each side of the basal segment; three pairs of white spots on the apical segments ..... *satyrus* Fabricius
   Abdomen with reddish hairs on each side of the basal segments; apical segments with two pairs of white spots 6
6. Third segment of abdomen with a band of white scales ..... *doryca* Boisduval
   Third segment of abdomen with a pair of white spots on the sides .. *inquinita*, n. sp.
7. Cell R_5 closed; mc entirely hyaline or almost so ..... *septentrionis*, n. sp.
   Cell R_5 open; apex of mc broadly fuscous ..... *sinuatifascia* Macquart
   Cell R_5 open; apex of mc hyaline ..... *cingulata* v.d. Wulp



Text-fig. 2. (*a*) Third antennal segment of *Hyperalonia* and *Exoprosopa*; (*b*) claw with a short basal tooth; (*c*) claw with a long and acute basal tooth.

Hyperalonia doryca Boisduval.

Anthrax dorycus Boisduval, Voyage de l'Astrolabe, Entom., ii, 1835, 665, tab. xii, fig. 12; Osten-Sacken, *Annals Mus. Civ. Genova*, xvi, 1882, 443; *Berlin. Entom. Zeitschr.*, xxvi, 1882, 112.—*Exoprosopa doryca*, v. d. Wulp, *Notes Leyden Mus.*, vii, 1886, 36; *Catal. Dipt. Sth. Asia*, 1896, p. 70; Meijere, Nova Guinea, v, Zool., 1906, 76.

♂. The head is mainly black; the occiput is black and is covered with short, depressed, black hairs and yellowish or reddish scales; the ocellar tubercle is prominent and is crowned with some erect black hairs; the frons is blackish but runs to brown towards the antennae; the face is brownish, both face and frons being clothed with dense black hairs; the eyes have a long and distinct bisecting line, and the indentation of their hind border is well developed; the first segment of the antennae is brown, the second and third are black, the latter with a bristle-like style of almost its own length, and the two former with stiff black hairs; the proboscis is stout and black.

The thorax is mainly black, bearing stiff, dense, reddish hairs in front and on the sides, and thin, depressed golden, and numerous erect black hairs on the dorsum; the bristles are well developed and black; the scutellum is brownish, covered with yellowish or golden, and black hairs and furnished with long, strong, black, marginal bristles; the pleurae have tufts of reddish hairs, with a few black hairs below the wing insertions; the squamae are brownish with a fringe of yellow scales; the halteres are black.

On the abdomen there is a very narrow band of yellow scales on the anterior border of the second segment and a broad band of white scales on the third, the latter being somewhat dilated on each side; the sixth and apical segments each have two admedian spots or areas of white scales; the rest of the dorsum is covered with black scales and scattered, erect, black hairs; there is a dense reddish tuft of hairs on each side of the basal segment and some long white hairs on each side of the third; the other segments are clothed laterally with long black hairs; the venter is black with numerous black hairs and with a broad, white, median stripe extending from the base for two-thirds of its length.

The legs are black covered with black scales and hairs; the basal tooth on the tarsal claw is short and obtuse.

The wings are subhyaline but glistening, and are dark fuscous along the fore margin, the colour descending to tinge the origin of the vein R_{2+3} and also the vein r-m; cells Cu, R_5, M_1, 2nd M_2 and M_4 are all open.

Length of body, 13-16 mm.; of wing, 13·5-17 mm.

The female differs from the male only in the slightly broader frons at the head vertex. The isolation of sexes in this genus has been rather difficult. The frons at the vertex in the female is so little broader than that of the male as to be almost imperceptible to those who have not studied the genus. I find the only certain method for their separation lies in the position and appearance of the unexserted genitalia. In the male the genitals lie somewhat to one side, while in the female they are centrally placed.

Hab.—Queensland: Kuranda and Rockhampton; N. S. Wales: Piper's Flats. This species is also recorded from the Solomon Islands and New Guinea.

Hyperalonia hemifusca, n. sp.

♂. The head is mainly blackish; the occiput is blackish above, red below, and is clothed with numerous black depressed hairs and brown scales, which

become somewhat whitish on each side of the hind indentations of the eyes; the ocellar tubercle is black and is crowned with some erect black hairs; the frons is brownish-black at the vertex and is clothed with erect black hairs and some light brown, almost golden scales; the face is brownish and is covered with similar scales and hairs though the latter are not as numerous as on the frons; the antennae have the first two segments brown, covered with long and short black hairs respectively, and the third black; the style is black and is about one-third the length of the third segment; the eyes possess a well marked indentation of the hind border and a long and fairly distinct bisecting line; the proboscis is black and short, being no longer than the oral aperture.

The thorax is black-brown, with thick, brown hairs in front and on the sides and black hairs and light brown scales on the dorsum; there is a patch or stripe of whitish hairs above the wing insertions; the bristles are well developed and black; the scutellum is brown with brown scales and long black marginal bristles; the pleurae are dusted with grey and have the tufts of hairs somewhat brownish; the squamae are large, flesh-coloured, with a short fringe of light brown scales; the halteres are yellowish with lighter knobs.

The abdomen is as long as the thorax, and has the first segment blackish, the others brown with decreasing black median areas; the whole of the dorsum is covered with light brown scales and erect, sparse, brown and black hairs, though the scales on the second segment appear somewhat lighter in colour; on each side of the basal segment there is a brownish or dirty white tuft of hairs; the venter is brown with brown scales and hairs.

The legs are mainly dark brown, the tibiae towards the apex, and the tarsi, being much darker, almost blackish; they are clothed with brown scales and black hairs; the basal tooth on the tarsal claw is short and obtuse.

The wings are hyaline with the base and foremargin for two-thirds the length fuscous, the colour descending to the crossvein between the cells M and M_4; cells R_5, M_1, M_2 and M_4 are all open; cell Cu is narrowly open; there is a greyish spot at the apex of cell M.

Holotype ♂, Somerset, North Queensland (no date); allotype ♀, Somerset, North Queensland (no date). Length of body, ♂, ♀ 12 mm.; of wing, ♂ 10 mm., ♀ 10·5 mm.

The female is similar to the male, although in the allotype the scutellum is rather reddish, and the median row of spots on the abdomen is more conspicuously marked.

Holotype and allotype are in the South Australian Museum. There are three paratype males in this collection all from Somerset.

Hyperalonia cingulata v. d. Wulp.

Exoprosopa cingulata v. d. Wulp, *Notes Leyden Mus.*, vii, 1885, 62.—*Hyperalonia cingulata*, Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 47; 1923, 73.

♂. The head is brown; the occiput is mainly black, and is covered with black hairs and light brown scales which are somewhat lighter in colour near the hind indentations of the eye borders; the ocellar tubercle is black and is crowned with a few erect black hairs; the face and frons are brown, clothed with light brown tomentum and numerous black hairs; the first two segments of the antennae are brown, the third black, longer than the first and second together, and with a style about half its length; the eyes have a well marked indentation at the hind

borders and the bisecting line is well developed; the proboscis is black, slightly longer than the oral opening.

The thorax is blackish, and bears stiff, dense, yellowish or brown hairs in front and on the sides, and some brown scales and hairs dorsally; the bristles are well developed, black; the scutellum is brownish with brown tomentum and long black marginal bristles; the squamae are brownish with a long fringe of yellowish scales; the halteres are brown.

The abdomen is blackish, with segments two and three largely brown laterally and each segment with a narrow brown posterior border; there is a band of white scales on the second segment, and the fifth, sixth, and apical segments are covered with similar scales; segments three and four are clothed with brown scales with a narrow posterior border of black scales; the tuft of hairs on each side of the first segment is dirty white or brownish; the venter is clothed with thin white pile.

The legs are brownish, with somewhat darker tibiae and tarsi, and are covered with brown and black scales and black hairs; the basal tooth on the tarsal claw is short and obtuse.

The wings are hyaline, with the base and the costal margin for two-thirds the length and one-half the breadth, light fuscous; the colour descends as a half-band to cover the basal third of the median cell, and the crossvein between the cells M and M_4 leaving a large clear area in cell M.

Length of body, 13-17 mm.; of wing, 15-18 mm.

The female is similar to the male, with the frons slightly broader at the vertex of the head.

Hab.—N. S. Wales: Darling River, Biniguy; Central Australia: Alice Springs; W. Australia: Swan River.

This species appears to be comparatively rare. In the material examined there were nine specimens, three of which were taken at Biniguy, near Moree, N. S. Wales. At first sight it is very similar to *H. sinuatifascia* but may be distinguished by the lighter brown colour of the wings, and the almost hyaline apex of the median cell.

Hyperalonia satyrus Fabricius.

Bibio satyrus, Fabricius, *Syst. Ent.*, 1775, 758; *Sp. Ins.*, ii, 1781, 415; *Mans. Ins.*, ii, 1787, 329.—*Musca satyrus*, Gmel., *Syst. Nat.*, v, 1792, 2831.—*Anthrax satyrus*, Fabricius, *Ent. Syst.*, iv, 1794, 259; *Syst. Ent.*, 1805, 123; Weidemann, *Dipt. Exot.*, 1821, 151; *Auss. zweifl. Ins.*, i, 1828, 322; Walker, *List Dipt. Brit. Mus.*, ii, 1849, 243; *Ins. Saund. Dipt.*, 1852, 166.—*Exoprosopa satyrus*, v. d. Wulp, *Tijd. v. Ent.* (2), iii (xi), 1868, 106; Osten-Sacken, *Cat. Dipt. Nth. America*, ed. 2, p. 87, note; v. d. Wulp, *Cat. Dipt. Sth. Asia*, 1896, 69.—*Exoprosopa funesta*, Walker, *List Dipt. Brit. Mus.*, ii, 1849, 242.—*Exoprosopa insignis*, Macquart, *Dipt. Exot.*, suppl. 5, 1855, 73; Bergroth, *Stett. Ent. Zeit.*, lv, 1894, 72.—*Hyperalonia satyrus*, Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 44 and 1923, 73.

♂. The head is brownish-black; the occiput is black covered with tawny scales, which appear whitish at the hind eye borders; the ocellar tubercle is black, prominent, and is crowned with some erect black hairs; the frons is blackish, brown medianly, and is covered with numerous black hairs and some yellowish scales; the face is brownish, with brown scales and black hairs; the first two segments of the antennae are mainly brownish, and are covered with long, and short, stiff black hairs respectively; the third segment is black, with a style of almost its own length; the eyes are distinctly indented at the hind borders and

the bisecting line is long and well marked; the proboscis is black and slightly longer than the oral aperture.

The thorax is black with brownish post-alar calli; anteriorly and laterally there are dense, yellowish or yellow-brown hairs, and dorsally some tawny scales and short, erect, black hairs; the hairs above the wing insertions are much lighter in colour than those on the sides and in front; the bristles are well developed and black; the scutellum is brownish with tawny scales and long black marginal bristles; the squamae are yellowish and bear a long fringe of whitish scales; the halteres are brown with lighter knobs.

The abdomen is black with brownish areas on each side of the basal segments; there is a band of yellowish white tomentum on the second segment and three pairs of white spots on the fifth, sixth, and apical segments; the remainder of the dorsum is clothed with black scales and sparse black hairs; on each side of the basal segment the hairs are yellowish, becoming white on the second; the other segments have black hairs on the sides; the venter is black and covered mainly with black scales; there is a broad basal and a narrow subapical band of white scales.

The legs are black, covered with black scales and hairs; the basal tooth on the claw is short and obtuse.

The wings are fuscous at the base and along the foremargin for two-thirds the length; the remainder of the wing is smoky, clearing to the inner border and apex; cells Cu, R_5, M_1, M_2 and M_4 all open. Female similar.

Length of body, 13-26 mm.; of wing, 15-23 mm.

Hab.—Queensland: Cape York, Lizard Is., Cairns, Meringa, Endeavour Rv., Pt. Denison, Rockhampton, Eidsvold, Brisbane, Chinchilla; N. S. Wales: Newcastle, Piper's Flats, Glenreagh; Northern Territory: Katherine, Malaranka, Port Darwin. There are some specimens in the Macleay Museum labelled South Australia. This species is also recorded from Port Moresby, New Guinea, and Moa and Badu Is., Torres Straits.

Hyperalonia bombyliformis Macleay.

Anthrax bombyliformis Macleay, in King's Narr. Surv. of South Austr., ii, 1830, 468; Weidemann, *Auss. zweifl. Ins.*, ii, 1830, 648; Walker, *List Dipt. Brit. Mus.*, 1849, 241; Kirby, *Ann. Mag. Nat. Hist.* (5), xiii, 1884, 458.—*Ligyra bombyliformis*, Newman, *Entom.*, 1, 1841, 220; Walker, *Ins. Saun. Dipt.*, 1852, 166.—*Exoprosopa punctipennis* Macquart, *Dipt. Exot.*, Suppl. 4, 1849, 106.—*Exoprosopa albiventris*, Thomson, *Eugenies Resa Dipt.*, 1869, 480.—*Hyperalonia bombyliformis*, Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 46; 1923, 73.

♂. The head is blackish; the occiput is blackish, covered with numerous depressed black hairs and with light brown scales close to the indentation of the hind eye margins; the eyes have a well marked indentation of the hind borders and a long and distinct bisecting line; the ocellar tubercle is black or brownish-black, prominent, and crowned with a few long black hairs; the frons is blackish above, brownish below, covered with brown scales and erect black hairs; the face is sharply conical, brownish, covered with brown scales and some black hairs, the latter being abundant at the mouth borders; the first two segments of the antennae are brownish, the third is black with a style of its own length; the proboscis is black, slightly longer than the oral opening.

The thorax is blackish-brown, with dorsal dark brown scales and some light brown and black hairs, the light brown hairs being conspicuous above the wing

insertions; the anterior and lateral hairs are dense, stiff, and brownish and there are stiff black hairs below; the bristles are well developed and brown; the scutellum is brownish-red, with dark brown scales and bearing long black marginal bristles; the squamae are dark with a long fringe of yellowish scales; the halteres are brown.

The abdomen is brownish-red, with median black areas enlarging towards the apex; the second segment is covered with a band of dense yellowish-white tomentum, and the fifth, sixth, and apical segments are clothed with white scales; the basal lateral tuft is yellowish and extends to the posterior border of the second segment; the venter is clothed with white pile, black at the sides and on the apex.

The legs are dark brown, covered with black scales and hairs; the basal tooth on the claw is short and obtuse.

The wings may be smoky with the base and costal margin fuscous, or hyaline with the same fuscous area, or entirely hyaline; there are always about eight fuscous spots on the disc of the wing, though they may be sometimes very light in colour; cells Cu and R_5 may be sometimes closed, and there may be an extra crossvein present in cell R_3.

The female is similar.

Length of the body, 14-22 mm.; of the wing, 13·5-20 mm.

Hab.—Queensland: Cape York, Somerset, Kuranda, Palm Is., Rockhampton, Westwood, Eidsvold, Brisbane, Peel and Stradbroke Islands, Chinchilla, Inglewood; N. S. Wales: Sydney, Port Hacking, Piper's Flats, Biniguy; Western Australia: King's Sound, Ulan, Beverly; Northern Territory; Katherine, Malaranka, Darwin, Groote Eylandt.

This species varies somewhat in the coloration of the wing, and I have seen one specimen in which the wing is quite hyaline without any traces of brown colour upon it. The spots are always present, however, and constitute a safe character for identification.

There yet remains some doubt as to whether this species should be called *bombyliformis* or *sylvanus*, the latter name being at present applied to a species of *Comptosia*. Banks collected his material along the Queensland coast about May and June. G. H. Hardy recently spent some time at the Palm Islands during June, and he informs me that the only species with spotted wings taken at that time was *bombyliformis*. It is therefore possible that the name *sylvanus* has been misapplied and should be attached to this species.

Hyperalonia sinuatifascia Macquart.

Exoprosopa sinuatifascia, Macquart, *Dipt. Exot.*, Suppl. 5, 1855, 72.—*Exoprosopa macraspis*, Thomson, *Eugenies Resa Dipt.*, 1868, 479.—*Hyperalonia argenticincta*, Bigot, *Ann. Soc. Ent. France* (7), xli, 1892, 343.—*Hyperalonia sinuatifscia*, Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 45; 1923, 73.

♂. The head is black; the occiput is brownish, with white or yellowish-white scales at the hind borders of the eyes; the eyes have a well marked indentation of the hind borders and a long bisecting line; the ocellar tubercle is black, crowned with a few erect black hairs; the frons and face are brownish, covered with brown scales and black hairs; the first two segments of the antennae are brownish, bearing long and short stiff black hairs respectively; the third is black with a style almost its own length; the proboscis is black, and slightly protrudes beyond the epistoma.

The thorax is blackish, covered dorsally with dark brown scales and black hairs and bearing long, dense, lighter brown hairs in front and on the sides; there is a stripe or patch of light brown or whitish hairs above the wing insertions; the bristles are well developed and black; the scutellum is brownish-red and bears long black marginal bristles; the squamae are dark with a long fringe of pale scales; the halteres are brown.

The abdomen is brownish-red, with a median dorsal row of black spots, the spots increasing in size apically; there is a band of white scales on the second segment, and the fifth, sixth and apical segments are also covered with white scales; the other segments are clothed with black scales, and towards the apex there are numerous erect black hairs; the tuft of hairs on each side of the base is yellowish-white; the venter is brown and is clothed with thin white pile.

The legs are mostly brown with darker tarsi and are covered with black hairs and scales; the basal tooth is short and obtuse.

The wings are hyaline with the base, the costal margin to the apex of the subcostal cell, two-thirds of cell R_1, half of R_3, one-third of R_5, apical portion of the median cell, almost all cell M, and one-third of the cubital cell, fuscous; there is a greyish spot at the apex of cell M.

The female is similar.

Length of body, 11-20 mm.; of wing, 12-19 mm.

Hab.—Queensland: Meringa, Westwood, Brisbane, Chinchilla; N. S. Wales: Biniguy, Barrington Tops, Toronto, Blackheath, Como; W. Australia: Ulan; N. Territory: Katherine. There are also some specimens in the Macleay Museum labelled South Australia.

Hyperalonia dentata, n. sp.

♀. The head is black; the occiput is black, clothed with yellow scales and short depressed black hairs; at the hind indentations of the eyes the scales appear whitish; the ocellar tubercle is prominent and black; the face and frons are black, clothed with dense yellow tomentum, which extends half way up the frons; the frons also has numerous erect black hairs; the antennae are black, the first and second segments being furnished with stiff yellow hairs; the proboscis is black.

The thorax is black with dense yellow hairs in front and on the sides and with shorter depressed tomentum of a similar colour on the dorsum; the bristles are well developed and black; the scutellum is brownish with yellow tomentum and long black marginal bristles; the pleurae also bear yellow hairs.

The abdomen is brownish, but black on the sides, about as long as the thorax, and with a somewhat rounded apex; it is uniformly clothed on the sides and on the dorsum with dense yellow scales and hairs, with which a few black hairs are mingled; the venter is black, also with yellow hairs, which become rather whitish towards the apex.

The legs are black, dusted with yellow scales; the basal tooth on the posterior tarsus is long and acute.

The wings are well developed and strong, brown at the base and the costal border for two-thirds its length; the veins are also surrounded with brown; the rest of the wing is smoky, clearing a little towards the inner margin; cells Cu, R_5, M_1, M_2 and M_4 all open.

Holotype female, labelled Victoria only. Length of body, 18 mm.; of wing, 19 mm. There is a single paratype in Mr. J. Mann's collection, also labelled Victoria. The male is unknown. The holotype is in the Queensland Museum.

HYPERALONIA INQUINITA, n. sp.

♀. The head is brownish-black; the occiput is brownish-black and bears numerous short depressed black hairs and some yellowish white scales, which are thickest near the hind indentations of the eyes; the frons is brownish-black and is covered with erect black hairs and yellowish-white scales; the face is brownish-black, becoming somewhat lighter in colour towards the inner eye margins and close to the antennae, and is clothed with similar tomentum; the first two segments of the antennae are brown, the second being about one-half as long as the first, bearing long and short black hairs respectively; the third is black, with greyish reflections, longer than the first and second together, and with a style about half its length; the ocellar tubercle is prominent, brownish, and crowned with some erect black hairs; the eyes possess a distinct indentation at the hind borders and a long and distinct bisecting line; the proboscis is black and does not project beyond the epistoma.

The thorax is black and bears stiff, dense, reddish hairs in front and on the sides, the hairs clothing the dorsum being thinner, and are almost golden in colour; there is a patch of hairs above the wing insertion which are much lighter in colour than those on the rest of the dorsum; the bristles are black; the scutellum is dark brown, but blackish at the base, with reddish-yellow tomentum and long, black, marginal bristles; the pleurae bear stiff black hairs, which become somewhat reddish above; the squamae are black with a long fringe of yellow scales; the halteres are blackish.

The abdomen is of the usual shape and curvature, as long as the thorax and mainly black; the second segment is clothed with yellowish-white tomentum, the band being somewhat dilated laterally; there is a small spot or area of white scales on each side of the third segment and two pairs of similar, though somewhat larger areas, on the sixth and apical segments; the rest of the dorsal tomentum consists mainly of black scales and a few black hairs; laterally the basal segment is clothed with long reddish hairs, which become yellowish on the sides of the second; there are a few white hairs mixed with the dense black hairs on the sides of the third; the remaining segments are clothed laterally with black hairs; the venter is black and black-pollinose.

The legs are black, and are covered with black scales and hairs; the basal tooth on the tarsal claw is short and obtuse.

The wings are divided into an upper brown half and a lower hyaline half, the outline of the brown reaching the base of the axillary lobe from whence it extends in an almost straight line to the apex of the subcostal cell, the lowest part of the inner border being the crossvein between cells M and M_4; there is a greyish spot at the apex of cell M; cells Cu, R_5, M_1, M_2 and M_4 are all open.

Holotype female, Bunya Mts., Q'land, 9th January, 1925. Length of body, 17 mm.; of wing, 17·5.

There is a single paratype female in the collection of the Macleay Museum, labelled Rockhampton.

The holotype is in the Macleay Museum.

HYPERALONIA SEPTENTRIONIS, n. sp.

♂. The head is brownish; the occiput is reddish, but black laterally, and covered with short depressed black hairs and white scales, which are most abundant near the posterior eye margins; the ocellar tubercle is prominent, rounded and black; the frons is blackish-brown and is clothed with dense, light

brown or dirty white scales, and numerous erect black hairs; the face is somewhat more brown and bears similar scales and some shorter black hairs; the cheeks are black; the first two segments of the antennae are brown, with stiff black hairs, the third is black, rather short, not much longer than the first; the style is black and equal in length to the third segment; the proboscis is black with brownish labella; the palpi are slender and black.

The thorax is black and has dense stiff brown hairs in front, and dark brown scales and some black hairs on the dorsum; on each side there is a definite stripe of white hairs; the bristles are black; the scutellum is brown with brown scales and black marginal bristles; the pleurae are dusted with grey and have brown hairs, which become somewhat reddish below the wing insertions; the squamae are flesh-coloured with a fringe of whitish scales; the halteres are brownish with reddish-yellow knobs.

The abdomen is brown with black median areas on segments two, three and four, the area decreasing in size in that order; there is a band of white scales on segment two, which is dilated on the sides, and the fifth, sixth and apical segments are also clothed with white scales; the remaining segments are clothed with brown and black scales and sparse black hairs, though there are traces of white scales on the sides of segments 3 and 4. The tuft on each side of the basal segments is whitish; the venter is brownish and white-pollinose.

The legs are dark brown with darker tarsi, and are covered with black and brown scales and black hairs.

The wings are hyaline with the base and fore margin brown, the costal cell being rather greyish at the base; the colour is dilated from the base to reach the median crossvein; cell R_5 is closed at the wing margin; cells Cu, M_1, M_2 and M_4 are all open.

Holotype male, Somerset, Nth. Q'land, McNamara. Allotype female, Somerset, Nth. Q'land, McNamara. Length of body, ♂ 13 mm., ♀ 15 mm.; of wing, ♂ 11 mm., ♀ 14·5 mm.

The female allotype differs slightly from the male in the colour of the scales, those on the female being somewhat golden. This is possibly due to the condition of the specimen. The wings are more broadly brown, the colour being deeper at the base and extending well past the vein r-m.

There are three paratypes all from the same locality, which, with the allotype and holotype, are in the collection of the South Australian Museum.

Genus Exoprosopa Macquart.

Exoprosopa, Macquart, *Dipt. Exot.* (1), 1840, 35; White, *Proc. Roy. Soc. Tasm.*, 1916, 205; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 47; 1923, 74.

Genotype, *Bibio capucina* F. by Rondani's designation.

The head is globular, and as broad as the thorax; the ocellar tubercle is prominent, rounded, and placed somewhat below the vertex of the head; the frons is raised and the face is sharply prominent, both face and frons being covered with hairs and sometimes scales; the antennae are widely separated at the base; the first segment is cylindrical, about twice as long as the globular second segment; the third is conical, generally as long as, if not longer than, the first and second together; the style is long, bristle-like and distinct; the eyes in both sexes are widely separated at the vertex; the bisecting line is usually long and distinct; the proboscis is short, with just the tip sometimes showing beyond the epistoma; the palpi are small and slender.

The thorax is quadrate, and is furnished with well developed bristles on the humeral and post-alar calluses, those on the post-alar callus being especially strong and directed backwards; the scutellum is broad and semicircular and bears long bristles on its margin; the squamae are large, with a fringe of scales, and the halteres are slender.

The abdomen is generally broad, somewhat flattened, as long as, or longer than the thorax, and covered with depressed scales and erect hairs; the male genitalia are not conspicuous, and the genitalia of the female are armed with a circlet of blunt spines.

The legs are slender; the fore tibiae are devoid of spines; the basal tooth on the claw is always long and acute; pulvilli are absent.

The wings are strong with a well developed axillary lobe and a distinct alula; cell R_3 possesses an interradial crossvein; the cubital cell is sometimes closed; cells R_5, M_1, M_2 and M_3 are all open; the venation is typical of that found in the Exoprosopinae. The range is world wide.

As far as is known, there are five species of this genus in Australia, all of which are described below, one being new. In appearance and habits they are similar to the species of *Hyperalonia*. Nothing is known of their life histories, but as the genitalia of the female bear a circlet of short, blunt, spines, they probably have the same host relationships as the species of *Hyperalonia*.

Distribution.—The most widely distributed species is *adelaidica*, which is recorded from the whole of the continent, excepting the extreme north; *stellifer* is confined to Western Australia and *marginicollis* to Queensland; *obliquebifasciata* and *dimidiata* are from Western Australia and Groote Eylandt, respectively. Groote Eylandt is in the Gulf of Carpentaria, so it is probable that *dimidiata* is an extralimital species. The genus is unknown from Tasmania, although Tasmania was recorded as the type locality of *obliquebifasciata*.

Key to the Species of Exoprosopa.

1. Abdomen blue or green ..... *marginicollis* Gray
   Abdomen black or brown 2
2. Wings brown with the apex only, broadly hyaline ..... *stellifer* Walker
   Wings brown with the hind margin, or part of it, and the apex also, hyaline 3
3. Wings cut sharply into a brown basal half and an apical hyaline half ..... *dimidiata*, n. sp.
   Wings not cut sharply into a basal brown and an apical hyaline half 4
4. Face covered with white scales; the brown of the wings not reaching the hind margin ..... *obliquebifasciata* Macquart
   Face covered with brownish scales; the brown of the wings reaches the hind margin where it may contain a large indented triangular hyaline area, or the area may be much reduced to form two somewhat circular areas .... *adelaidica* Macquart

Exoprosopa marginicollis Gray.

Anthrax marginicollis Gray, in Griffith's *Animal Kingdom*, xv, Ins. ii, 1883, 780, Pl. cxxv, fig. 6.—*Exoprosopa marginicollis*, Hardy, *Proc. Roy. Soc. Tasm.*, 1923, p. 74.

A bright metallic species, readily recognized by the metallic green or blue thorax, bearing anterior and lateral white hairs, those on the sides appearing as two white stripes, and a metallic blue or green abdomen. The wings are deep brown, almost black, with the apex and a large triangular area on the inner border hyaline. Length of body, 15-17 mm.; of wing, 14·5-16 mm.

Hab.—Queensland: Port Denison, Westwood.

The blue and green colouring of the thorax and abdomen appear to be interchangeable. I have seen some specimens in the Macleay Museum that are almost

entirely blue, and there are other specimens in which the abdomen is green or blue, and thorax, blue or green.

Exoprosopa obliquebifasciata Macquart.

Exoprosopa obliquebifasciata, Macquart, *Dipt. Exot.*, suppl. 4, 1850, 107, Pl. x, fig. 5; *E. obliquefasciata*, White, *Proc. Roy. Soc. Tasm.*, 1916, 205; *E. obliquifasciata*, Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 48, and 1923, 74.

♀. The head is black; the occiput is black, and is clothed with white scales which become silvery near the indentations of the posterior eye borders; the frons is blackish above and brown below; the face is brown, both frons and face with silvery-white scales and some black hairs, the latter particularly numerous on the frons; the first two segments of the antennae are brown, covered with black hairs, the third is somewhat darker, rather stout, about as long as the first segment; the style is black, and is slightly longer than the third segment; the ocellar tubercle is brownish; the hind borders of the eyes have a distinct indentation, but the bisecting line is rather faint; the proboscis is black and slender.

The thorax is black with dorsal brown and white scales and black hairs; the white scales occupy the anterior part and extend along each side, above the wing insertions, as a distinct stripe; the collar consists of stiff, dense, brown hairs; the bristles are black; the scutellum is brownish-red, but somewhat blackish at the base; the marginal bristles are long and black; the pleurae are clothed with reddish-brown hairs; the squamae are large, light brown, and are fringed with white scales; the halteres are brownish with yellowish knobs.

The abdomen is elongate, longer than the thorax, brownish, with a dorsal row of black spots, decreasing in size apically; the second segment is clothed with a band of white scales, which are also present on the apical segments; the tuft of hairs on each side of the base is white; the venter is brownish with white scales; the genital spines are long and reddish.

The legs are slender, brown, with the tarsi somewhat darker.

The wings are rather long and slender, hyaline, but brown at the base and along the fore margin for two-thirds the length and half the breadth, the colour descending at its apex to the middle of the vein M_1, where it is dilated to cover the basal two-thirds of cell M_1, and the apex of the median cell; there is a small greyish spot at the apex of the second basal; the median cell is very long and narrow as is also the cubital.

Length of body, 11 mm.; of wing, 12 mm.

Hab.—Beverly, Western Australia.

I have only seen a single specimen of this species, and it is in the South Australian Museum. Although this species was described from Tasmania, I feel sure it is a case of misnamed locality, as no species of the genus is known from there and this specimen agrees remarkably well with Macquart's description.

Exoprosopa adelaidica Macquart.

Exoprosopa adelaidica, Macquart, *Dipt. Exot.*, suppl. 5, 1855, 70, Pl. iii, fig. 4; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 48.—*Exoprosopa laterimbata*, Bigot, *Ann. Soc. ent. France* (7), lxi, 1892, 346; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 47.

♂. The head is black; the occiput is black, covered with depressed black hairs and with numerous yellow-white scales at the inner borders of the eyes, near the indentations; the frons is brown and is covered with erect black hairs and some brown scales, the latter being particularly dense on the basal half; the face

is sharply prominent, brown, and covered with dense brown scales and black hairs; the first segment of the antennae is brown and bears long black hairs, the second may be brown or blackish, and is furnished with short black hairs, the third is black with a style about two-thirds its length; the proboscis is black with the tip sometimes exserted.

The thorax is blackish with dorsal dark brown and black tomentum, and long stiff brown hairs in front; on each side above the wing insertions there is a stripe of whitish or brown hairs, which reaches from the humeral to the post-alar callus; the bristles are black; the scutellum is reddish-brown or light brown and has brown and black scales and long, black, marginal bristles.

The abdomen varies greatly in ground colour, the most usual colour being black with the three basal segments largely brownish laterally; the black in some species is reduced to a broad median stripe, which decreases in size apically; the dorsum is covered mainly with black scales with scattered black hairs; there are two spots or areas of white scales on each side of the third segment, the areas sometimes meeting to form a complete band; the sixth segment and apex are also covered with white scales; the lateral pubescence consists mainly of black hairs, though on the sides of the basal segments they may be replaced wholly or partly by whitish or yellowish hairs.

The legs are blackish-brown or brown and are clothed with black scales and hairs.

The wings are brown with the apex broadly hyaline and a large triangular, indented, hyaline area below, the apex of this area reaching to the upper border of the median cell; the size of this area appears to vary tremendously, being sometimes reduced to two irregular spots; there is a small greyish spot at the apex of the median basal cell; the cubital is sometimes narrowly open or closed at the wing border.

Length of body, 8-22 mm.; of wing, 9·5-21 mm. The female is similar.

Hab.—Queensland: Meringa, Pt. Denison, Rockhampton, Brisbane, Eidsvold, Chinchilla, Westwood; N. S. Wales: Toronto, Biniguy, Sydney, Cobar; W. Aust.: Swan River, Cue, Beverly, Northam, Cunderdin, Perth; N. Territory: Woodah, Katherine; and also from South Australia.

Under this name I have been compelled to place a number of specimens which vary very greatly in the general colour, size and pubescence. The various specimens appear to fall into three more or less distinct forms: (1) A very large form in which the lateral stripes on the thorax are white, the white scales on the third segment of the abdomen are confined to two distinct lateral areas, the brown of the wings is dark and the hyaline area at the inner margin is not completely triangular, i.e. the brown band does not reach the inner border, and its outline is rather distinct; (2) medium sized specimens, in which the lateral stripe of the thorax is usually brown, the white scales on the third abdominal segment form a definite band, and the brown of the wings is also dark, but the triangular hyaline area at the inner margin is complete; (3) specimens in which the triangular white spots of the abdomen are separate, the brown of the wings much lighter, the hyaline area at the inner margin much reduced, sometimes being diminished to two spots, the abdomen mainly brown, and the lateral tuft of hairs at the base of the abdomen whitish. It is possible that more than one species is represented here, but I have been unable to find definite characters for their separation, the three forms mentioned above being connected by intermediate forms.

EXOPROSOPA STELLIFER Walker.

Anthrax stellifer, Walker, *List Dipt. Brit. Mus.*, ii, 1849, 244.—*Litorhynchus stellifer*, Walker, *Ins. Saund. Dipt.*, 1852, 166.—*Exoprosopa stellifer*, Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 47; 1923, 74.

♂. The head is blackish; the occiput is black or brownish with numerous short depressed black hairs and some brownish scales; the ocellar tubercle is black; the frons is black above, brownish below; the face is sharply prominent, brownish, but black on each side of the upper mouth border, both face and frons covered with dense black hairs and brown scales; the first two segments of the antennae are brown, covered with black hairs; the third is black, about as long as the first segment; the proboscis is black with brownish labella, slightly longer than the oral aperture; the palpi are slender and brown.

The thorax is black, with dense, thick, stiff, anterior brown and black hairs and a stripe of whitish hairs along each side extending from the humeral to the post-alar callus; the dorsum is covered with numerous upright and depressed black hairs and thinner, depressed, dark brown tomentum; the bristles are well developed and black; the scutellum is reddish-brown covered with black and brown scales and bearing black marginal bristles; the pleurae are blackish with tufts of stiff black hairs; the squamae are brown with a dark scaly fringe; the halteres are dark.

The abdomen is black with large reddish-brown lateral areas on the basal segments, covered with black scales and hairs; on each side of the third segment there is a triangular spot or area of white scales; the sixth and apical segments are also covered with white scales; laterally the first segment has a tuft of whitish hairs; the second, black hairs with which a few white hairs are mixed; all the rest have black hairs; the venter is mainly black, some of the apical segments being partly brown, with black scales and hairs.

The legs are brown, with somewhat darker tarsi, and covered with black scales and hairs.

The wings are dark brown with a broadly dull hyaline apex; the brown occupies the wing from the base to near the apex of the costal cell thence across to the apex of vein M_{3+4}; cell R_5 is open; the cubital is closed at the wing border; the brown contains five hyaline or greyish spots in relation to r-m, M_{3+4}, im and the median cell.

The female is unknown.

Length of body, 14-21 mm.; of the wing, 12·5-19 mm.

This species is apparently very rare, as I have only seen two specimens in the many collections examined; one in the Queensland Museum from Cunderdin, W. Australia, the other in the Macleay Museum, labelled West. Australia.

These two specimens are distinct from one of the groups of *adelaidica* in the amount of brown of the wing and in the position of the hyaline spots. In *E. adelaidica* the apical edge of the brown extends from the apex of the costal cell across the wing to colour the apical portion of cell M_1 and most of the basal portion of cell 2nd M_2, while in *E. stellifer* the apical part of cell M_1 is not so extensively coloured and the base of 2nd M_2 is quite clear.

The position of the hyaline spots in the wing is also distinctive and even with a closing up of the large triangular hyaline area at the inner margin of the wing of *adelaidica*, no hyaline spots would be left around r-m or the basal part of M_{3+4}.

EXOPROSOPA DIMIDIATA, n. sp.

♂. The head is black; the occiput is blackish and is clothed with short, depressed, black hairs and brownish scales; the post-vertical furrow is well marked and deep; the ocellar tubercle is blackish, prominent, and crowned with a few erect, short, black hairs; the frons is blackish, covered with erect, black hairs and brown scales; the face is sharply prominent, blackish, but somewhat brown on each side of the epistoma below the antennae, and covered with similar tomentum; the first two segments of the antennae are brownish-black, bearing long and short black hairs; the third is black with a style about half its length; the proboscis is black, and is slightly longer than the oral aperture; the eyes have a well marked indentation of the hind borders and a distinct bisecting line.

The thorax is blackish, clothed with erect black hairs and brown scales; in front there are stiff, dense, yellow brown hairs, and on each side above the wing insertion, there is a stripe of similarly coloured, but much shorter and more appressed hairs; the bristles are black; the scutellum is brown, somewhat darker medianly, and covered with light brown scales and bearing long, black, marginal bristles; the pleurae are provided with stiff black hairs; the squamae are dark, with a fringe of long, dark scales; the halteres are blackish with somewhat lighter knobs.

The abdomen is black, rather short, not as long as the thorax, and clothed mainly with black scales and hairs; there is a band of white scales on the third segment, the sixth and apical segments being also covered with white scales; on the sides the hairs are black, except near the base, where the hairs are dirty white; the venter is brown, clothed with black scales and hairs.

The legs appear to be uniformly black, and bear black scales and hairs.

The wings are rather stout, cut sharply into dark brown and hyaline halves, the inner margin of the brown extending from near the apex of the cubital cell across the wing to the apex of the subcostal cell; there is a greyish spot at the apex of the median basal cell; the bifurcation of R_{2+3} and R_{4+5} takes place opposite r-m; the terminal loop of R_{2+3} is well developed; cells Cu, R_5, M_1, M_2 and M_4 are all open.

Holotype male, Groote Eylandt, H. E. Warren. Length of body, 15 mm.; of wing, 13 mm. The holotype is unique and is in the South Australian Museum.

Genus VILLA Lioy.

Villa, Lioy, *Atti Istit. Veneto.* (3), ix, 1864, 732.

Genotype, *Anthrax concinnus* Meigen, by original designation.

The head is large and globular, as broad as the thorax or almost so; the eyes are separated in both sexes, but wider apart in the female; the ocellar tubercle is rounded, prominent, and usually placed at the vertex of the head; the frons is raised, and in the male varies somewhat in its width at the vertex of the head, sometimes being but slightly broader than the ocellar tubercle, and again about two and a half times as broad; the face may be sharply or bluntly prominent, or rounded, both face and frons being usually covered with scales and hairs; the antennae are set well apart from each other at their base and are inserted somewhat above the middle of the front plane of the eyes; the first segment is cylindrical, about twice as long as the second; the third varies in shape from conical to subulate, the flagellate portion being very thin or rather stout; there is usually a minute spine present at its apex; the proboscis is short and thick and rarely projects beyond the epistoma to any extent; the palpi are small and slender.

The thorax is quadrate, broadest behind, flattened, and covered in front and on the sides with dense, stiff hairs; the pre- and post-alar bristles are usually well developed; the scutellum is broad and semicircular, and bears on its margin numerous bristles; the squamae are rather large with a fringe of scales, and the halteres are slender.

The abdomen is generally longer than the thorax, convex above and flattened below, sometimes broad and almost straight-sided; there are usually bands of scales on the dorsum and long hairs on the sides, especially near the base; the male genitalia are set on one side and the genitalia of the female are armed with a circlet of spines at the apex.

The legs are slender, of the usual form found in the Exoprosopinae, but the fore tibiae may sometimes bear small spines; there is no basal tooth on the claw.

The wings are strong, with the typical venation of the Exoprosopinae; the cell R_3 is sometimes divided by an inter-radial vein; cells R_5, M_1, M_3 and M_4 are always open; the cubital cell is very rarely closed.

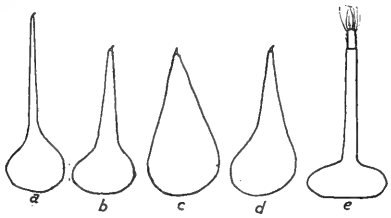
Range.—World-wide.

In the material under examination I have recognized thirty-one species as belonging to this genus, nineteen of which are described, eight being considered new. Bezzi recognized two genera, *Villa* and *Thyridanthrax*, into which these species might be placed, his characters for their separation being the presence or absence of minute spines on the fore tibiae, the roundness or convexity of the face, and the shape of the third antennal segment. *Fuscicostata* is a true species of *Villa* in possessing all these characters; *commista* has a rounded face, and a very slender third antennal joint, but the fore tibiae are devoid of spines. I have seen a new species in the Queensland Museum, not described in this revision, in which the fore tibiae possess distinct spines, but the face is sharply convex and the third antennal segment is rather stout. Most of the species I have placed in the genus possess one or two of these characters, but very rarely all of them. Bezzi, himself, admitted that the separation of the species of *Villa* and *Thyridanthrax* of the Ethiopean Region was extremely difficult, and the only constant character available was the presence or absence of spines on the fore tibiae. Even this character does not hold outside that region as there are species of *Villa* in America which have the fore tibiae absolutely devoid of spines. I am therefore strongly inclined to make *Villa* and *Thyridanthrax* synonymic, but refrain from doing so until I have an opportunity of seeing some exotic species of *Thyridanthrax*.

The separation and identification of the small species of this genus has been exceedingly difficult. There are apparently many small species that are extremely variable, and until further material is available, I do not intend to attempt to describe many of these species which do not appear valid. The small species described herewith are all represented by good series and are easily distinguished from each other.

The members of this genus are very small to rather large flies, prettily marked with yellow, brown and black tomentum, and with wings that are rarely completely hyaline, but usually brown at the base and along the fore margin to various depths. The adults, like the other genera of the subfamily, are particularly abundant in arid country, and obtain their food from the flowers of low growing shrubs and weeds. Little is known of the life histories, but two small species have been obtained from the cocoons of the Noctuid genera *Leucania* and *Agrotis*.

Distribution.—It is interesting to note that while the genera, *Hyperalonia* and *Exoprosopa*, are unknown from Tasmania, certain species of *Villa* are to be found there in abundance, three species, *minor*, *velox*, and *argentipennis*, being confined to that Island. New South Wales possesses five species, *quinqueguttata*, *brunea*, *varipennis*, *aprica*, and *fumea*, all of which will probably be found to have a more extensive range. The species limited to Queensland is *albobasalis* which, being a Western form, may also be represented in New South Wales, and possibly extends to Western Australia; *rava* occurs in both Queensland and New South Wales and *albata* in Western Australia only; *fuscicostata*, *simplex*, *nigricosta*, *alterna*, *pellucida*, and *vitrea* are all found in Tasmania and from there are gradually extending north and west.



Text-fig. 3. Third antennal segment of (*a*) *Villa commista* Macq., (*b*) *V. alterna* Walk., (*c*) *V. varipennis*, n. sp., (*d*) *Pseudopenthes fenestrata*, n. sp., and (*e*) *Anthrax maculata* Macq.

Key to the Species of Villa.

1. Wings spotted ..... *quinqueguttata*, n. sp.
   Wings not spotted 2
2. Large species only, with smoky wings 3
   Large and small species with the wings wholly or partly hyaline, small species with the wings somewhat smoky 4
3. Abdomen with a narrow band of white scales on the fourth segment and a narrow band of brown scales on the third ..... *alterna* Walker
   Abdomen with a broad band of white scales on the fourth segment, third segment with black scales only ..... *fumea*, n. sp.
4. Small species with the wings brown or smoky, but clearer at the apex; cell R_3 divided by a crossvein ..... *varipennis*, n. sp.
   Species with the wings not as above; cell R_3 rarely with a crossvein 5
5. Wings clearly divided into a basal brown half and an apical hyaline half 6
   Wings hyaline, or at most brown at the base and along the fore border 7
6. Basal half of wings dark brown; thorax with reddish or yellowish hairs in front and on the sides; fourth segment of abdomen with a large triangular area of white scales on each side ..... *commista* Macquart
   Basal half of wings light brown; thorax with brown hairs in front and on the sides; fourth segment of abdomen with a complete but narrow band of white scales ..... *obscura* Macquart
7. Species with wings completely hyaline, or brown at the base and along the fore margin, the colour rarely extending past the bifurcation of the veins R_{2+3} and R_{4+5}* 8
   Species with wings brown at the base and along the fore margin, the colour extending to or past the bifurcation of the veins R_{2+3} and R_{4+5} 16
8. Wings hyaline or at most tinged brown at the base and along the course of the closely adjacent veins Sc and R_1 9
   Wings brown at the base and along the fore margin 12
9. Face covered with white scales, a small species ..... *trivincula*, n. sp.
   Face covered with brown scales 10

10. A very small species with completely hyaline wings and the body possessing erect white hairs ..... *albata*, n. sp.
A small species with the wings tinged brown at the base only, thorax clothed with white hairs; abdomen with brown and white scaly bands .... *minor* Macquart
Thorax clothed with brown or yellow-brown hairs; wings tinged brown at the base and along the course of the closely adjacent veins Sc and R_1 11
11. Thorax with brown and a few whitish hairs; frons in male rather broad at the vertex ..... *brunea*, n. sp.
Thorax with yellow-brown hairs; frons in male rather narrow at the vertex ..... *vitrea* Walker
12. Abdomen rather broad, its lateral pubescence being almost unicolorous to the middle of the third segment at least; fore tibiae with distinct spines; a large species ..... *fuscicostata* Macquart
Abdomen not very broad; its lateral pubescence extending at most unicolorous to the posterior border of the second segment; fore tibiae with hairs only 13
13. A medium-sized species, with the wings brown at the base and for a short distance along the fore margin ..... *albobasalis*, n. sp.
Small species with the wings conspicuously brown at the base and along the fore margin 14
14. Face covered with white scales ..... *simplex* Macquart
Face covered with brown scales 15
15. First segment of abdomen with white scales; the brown of the fore margin rather light ..... *nigricosta* Macquart
First segment of abdomen with black and brown scales; the fore margin of the wing dark brown ..... *pellucida* Walker
16. Thorax with some white hairs on the shoulders; a rather small species ..... *argentipennis* White
Thorax with brown or yellow-brown hairs; shoulders without white hairs 17
17. Hairs on each side of the base of the abdomen, white 18
Hairs on each side of the base of the abdomen, yellowish ..... *velox* White
18. Face covered with white scales; abdomen with narrow brown bands .. *aprica*, n. sp.
Face covered with brownish scales; abdomen with broad brown bands .. *rava*, n. sp.

* *Note.*—In *pellucida* the bifurcation of R_{2+3} and R_{4+5} is sometimes tinged brown.

Villa fuscicostata Macquart.

Anthrax fuscicostata, Macquart, *Dipt. Exot.*, suppl. 1, 1846, 111; Schiner, *Reise Novara*, 1868, 125; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 49.—*Anthrax marginata*, Walker, *Ins. Saund. Dipt.*, 1850, 178; White, *Proc. Roy. Soc. Tasm.*, 1916, 210.

♂. The head is black; the occiput is black, covered with somewhat whitish scales; the frons is black, slightly broader than the ocellar tubercle at the vertex, clothed with numerous erect black hairs and some yellow-white or brownish scales, the latter being more conspicuous on its lower half; the face is also black, rounded, and covered with dense yellow-white or brownish scales, with which are mingled a few black hairs; the antennae are entirely black, the third segment thinly attenuated and much longer than the first and second segments together; there is a minute spine at its apex; the proboscis is black, stout, and not longer than the oral aperture; the eyes possess a well marked indentation at their hind borders and a long and distinct bisecting line.

The thorax is blackish, with long, dense, whitish to brownish anterior and lateral hairs, and some brown and black scales on the dorsum; above the wing insertions there is a patch or stripe of hairs almost whitish in colour; the bristles are well developed and black; the scutellum is blackish or sometimes dark brown, covered with brown and black scales and bearing long, black, marginal bristles; the pleurae are partly covered with whitish or brownish tufts of hairs; the halteres are brown with whitish knobs.

The abdomen is broad, somewhat straight-sided, flattened, and clothed on the dorsum with white, brown, and black pubescent bands, the white bands being placed on the second, fourth and sixth segments, and the brown bands on the third and fifth segments; with these bands the bands of black scales alternate; the apex is covered with white scales; there is a long whitish to yellowish lateral growth of hairs extending from the base to the middle of the third segment, sometimes even further, the hairs on the sides of the other segments being mixed black and white; the venter is clothed with thin white pile.

The legs are black, covered with brownish scales and black hairs; the fore tibiae bear distinct, though rather weak spines.

The wings are hyaline with the base and fore margin brown; the brown never, or very rarely, covers the bifurcation of the veins R_{2+3} and R_{4+5}; cell R_3 never divided.

The female is very similar with a much broader frons.

Length of body, 8-14 mm.; of wing, 8-15 mm.

Hab.—Queensland: Palm Is., Pt. Denison, Westwood, Brisbane, Chinchilla; N. S. Wales: Moonie Rv., Moree, Sydney, Jindabyne, Barrington Tops, Wentworth Falls, Piper's Flats, Toronto, Mt. Kosciusko; S. Australia: Blackwood, Eyre Penin.; W. Australia: Beverly, Ulan; N. Territory: Metah; Tasmania: Hobart, George Town.

Two specimens collected by A. P. Dodd on the Moonie River in New South Wales are somewhat different from the other members of the series. They have a generally broader abdomen and the long hairs at its sides are almost completely whitish to the apex, very few black hairs showing. Other specimens have the general pubescence more yellowish than white, but the colour is probably due to age, as they were all very old specimens.

Villa commista Macquart.

Anthrax commista, Macquart, *Dipt. Exot.* suppl. 4, 1850, 109; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 48.—*Anthrax consimilis*, Thomson, *Eugenies Resa*, Dipt., 1868, 481.—*Anthrax albirufa*, Walker, *Trans. Ent. Soc. London*, iv, 1857, 143.

♂. The head is black; the occiput is black covered with whitish scales; the frons is black, clothed for the main part with erect black hairs; the face is black, covered with brown scales, which become yellowish-white on each side and extend half way up the frons; the antennae are black with dense black hairs at their base; the third segment is thinly subulate, with a very minute terminal spine; the proboscis is black, stout, and does not project beyond the epistoma; the eyes are separated at the vertex of the head by slightly more than the width of the ocellar tubercle, and possess a well marked indentation of the hind borders and a long and distinct bisecting line.

The thorax is black, covered dorsally with black and brown scales, the latter forming three indistinct longitudinal stripes; the anterior and lateral pubescence consists of long, dense, yellow, reddish, or orange hairs; there are traces of thin hairs of the same colour immediately anterior to the scutellum; the bristles are well developed and black or brown; the scutellum is black covered with yellow and black scales and bearing long brown and black marginal bristles; the pleurae are covered with long yellow or orange hairs, and below the wing insertions there are some clear white hairs; the squamae are dark with a fringe of yellow scales; the halteres are brownish.

The abdomen is rather broad, somewhat similar to that of *fuscicostata*, blackish-brown and clothed mainly with black scales and hairs; there is a very narrow band of whitish or light brown scales on the second segment and two distinct areas of white scales on each side of the fourth; the apex is covered with white scales; on each side of the base there is a tuft of clear white hairs which extend to the middle of the second segment; the hairs on the sides of the other segments are black. The venter is clothed with thin silky white pile with a broad black apical band.

The legs are black, clothed with shining black scales and black hairs; the fore tibiae are devoid of spines.

The wings are divided into a dark brown basal half and an apical hyaline half, the dividing line extending from near the apex of the cubital cell to the apex of the costal cell, leaving the lobe and the interior of the cubital cell more or less hyaline; there is a greyish spot at the apex of the median basal cell; cell R_3 never divided by a crossvein.

The female is similar, except that the frons is broader between the eyes.

Length of body, 10-15 mm.; of wing, 10·5-16 mm.

Hab.—Q'land: Pt. Denison, Rockhampton, Brisbane, Caloundra; N. S. Wales: Gosford, Sydney, Port Hacking, Piper's Flats; W. Australia: King George's Sound.

In Hardy's catalogue, *Anthrax albirufa* had been listed as a synonym of *Anthrax fuscicostata*, but I think Walker's description fits *commista* more readily.

In the series of this species under examination, there are three specimens in which the white areas on the sides of the fourth segment of the abdomen are extended so as to meet, forming a band which is extremely narrow medianly. The dense hairs on the front and sides of the thorax are usually a beautiful orange, but in a rather small specimen, collected in Brisbane, these hairs are more yellow than orange.

Villa obscura Macquart.

Anthrax obscura, Macquart, *Dipt. Exot.*, suppl. 1, 1846, 112.

♂. The head is blackish; the occiput is dull black-brown with brownish scales, which become whitish, laterally; the postvertical furrow is well marked and deep; the ocellar tubercle is shining black and is crowned with a few erect black hairs; the frons is blackish, narrow at the vertex, and clothed with numerous black hairs, and on the basal half with some brown scales; the face is black, prominent, and covered with black hairs and dense, light brown scales; the antennae are entirely black, with long stiff, black and brown hairs on the first segment, and with short black hairs on the second; the third segment is longer than the first two together, with a rather stout styliform portion which terminates in a very minute spine; the proboscis is short and black; the eyes have a well marked indentation at their hind borders and a long and distinct bisecting line.

The thorax is blackish, with dorsal dark brown, depressed tomentum, and long dense anterior and lateral light brown hairs; the bristles are mainly brownish, but a few are black; the scutellum is brown or reddish-brown, blackish basally, covered with dark brown and black scales and bearing long, thin, marginal bristles; the pleurae are furnished with tufts of long whitish-brown hairs; the squamae are brownish with a fringe of brown scales; the halteres are yellowish with whitish knobs.

The abdomen is blackish, with brownish lateral areas on segments one to four, the areas decreasing in size apically; the first segment is covered with black

tomentum and sparse brownish hairs, the second with a white anterior, a median brown and a posterior black band, the third mainly with brown scales, the fourth, with an anterior white and a posterior black band, the fifth mainly with brown scales, and the sixth and apical segments with white scales; the hairs on each side of the first segment are clear white and extend for two-thirds of the second segment; the remaining segments bear mostly black hairs laterally; the venter is brownish, covered with thin white pile.

The legs are mainly brown covered with brown scales and black hairs; the fore tibiae are devoid of spines.

The wings are hyaline with the base, the fore margin for two-thirds the length and one-half the breadth, light brown; the apex and hind margin are clear, so that the basal half of the wing is brown and the apical half hyaline; there is a hyaline or greyish spot at the apex of the median basal cell; the cubital cell and R_5 are open.

The female is similar.

Length of body, 9-13 mm.; of wing, 8-12·5 mm.

Hab.—Q'land: Westwood, Eungella Range, Brisbane, Chinchilla; N. S. Wales: Forbes, Murrurundi, Sydney, Gravesend; W. Australia: Beverly, Swan Rv. There are two specimens labelled South Australia only.

This species was particularly common at Gravesend, North-west New South Wales, during March, 1927, when no less than twenty-eight specimens were taken in two days. In one specimen from this locality, the brown of the wings is not sharply separated from the hyaline portion, so that the wings appear suffused with brown throughout their width.

In two others, the brown of the wings is diffused from the base only to a very small extent, so that the wings are not divided into equal, or nearly equal, brown and hyaline halves.

Villa minor Macquart.

Anthrax minor, Macquart, *Dipt. Exot.*, suppl. 4, 1850, 11; White, *Proc. Roy. Soc. Tasm.*, 1916, 208; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 49; 1923, 75.

♀. The head is black; the occiput is black covered with brown scales; the frons is black, covered with erect black hairs and brown scales, the latter more dense towards the antennae; the face is more or less rounded, not very prominent, clothed with black hairs and brown scales; the antennae are entirely black, the third segment thinly attenuated and with a minute terminal spine; the proboscis is stout and black and is concealed within the oral aperture; the eyes have a well marked indentation of the hind borders and a fairly distinct bisecting line.

The thorax is black, with dense white hairs in front and on the sides, and brown scales and some black hairs dorsally; the white hairs are continued in an almost unbroken line round the thorax and close to the scutellum; the bristles are black; the scutellum is black, covered with brown scales and bearing thin, short, black, marginal bristles; the pleurae are furnished with white hairs above, and brownish hairs below; the squamae are dark, with a short fringe of white scales; the halteres are pale brown with blackish knobs.

The abdomen is black, somewhat slender, and clothed with broad white and narrow brown scaly bands, the white bands being on the first, second, and fourth segments; the apex is also clothed with white scales; the brown bands are placed on the second, third, fourth, fifth, and sixth segments; the hairs on each side of the basal segment are white and extend a little distance past the

anterior border of the second segment; the venter is mainly brown, with similar bands of white and brown scales.

The legs are mainly brown, with rather darker femora and tarsi, covered with brown scales and black hairs; the fore tibiae bear hairs only.

The wings are completely hyaline except for the base which is tinged brown.

Length of body, 8 mm.; of wing, 6·5 mm.

The description is taken from two females in the collection of Mr. G. H. Hardy, taken in Tasmania at Dunalley and Mangalore respectively.

Villa alterna Walker.

Anthrax alterna, Walker, *List Dipt. Brit. Mus.*, ii, 1849, 261; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 48.—*Anthrax alternans*, Macquart, *Dipt. Exot.*, suppl. 4, 1850, 110; White, *Proc. Roy. Soc. Tasm.*, 1916, 208.

♂. The head is black; the occiput is blackish, covered with depressed black hairs and brown scales; the frons is black, with numerous erect black hairs and some brown scales on its lower half; the face is blackish, prominent, covered with brown scales and some black hairs; the antennae are entirely black, the third segment with a somewhat stout styliform portion and a minute terminal spine; the proboscis is black, and does not project beyond the epistoma; the hind borders of the eyes have a well marked indentation and a long and distinct bisecting line.

The thorax is brownish-black, covered dorsally with black and brown scales, the brown scales forming three well defined longitudinal stripes; there are some whitish hairs above the wing insertions, and also immediately anterior to the scutellum; the hairs in front and on the sides are brownish; the scutellum is brownish, covered with brown and black scales and provided with long, black, marginal bristles; the pleurae have a somewhat whitish tuft of hairs above, and brownish or reddish hairs below; the squamae are blackish with a fringe of white scales; the halteres are brownish with pale knobs.

The abdomen is mainly blackish, with bands of white scales on the second, fourth, sixth and apical segments and of brown scales on the second, third, fourth, fifth, and sixth segments, the bands on the third and fifth segments being particularly broad; the rest of the dorsal tomentum consists of black scales and a few black hairs; on each side of the first segment are some dirty white hairs, and on the anterior half of the second, clear white hairs; the lateral pubescence of the other segments is composed mainly of black hairs; the venter is covered with brown and white scales and hairs.

The legs are blackish or brownish, covered with shining brown scales and black hairs; the fore tibiae are devoid of spines.

The wings are suffused with brown, the colour being more marked at the base and along the costal border for two-thirds the length and half the breadth, leaving the apex and inner margin somewhat clearer, but not quite hyaline; cell R_3 without an interradial.

The female is similar.

Length of body, 10-12 mm.; of wing, 9-11 mm.

Hab.—Q'land: Brisbane, Chinchilla; N. S. Wales: Barrington Tops, Camden, Piper's Flats; Sth. Australia: Franklin's Is.; W. Australia: Mundaring, Swan Rv.; Tasmania: Hobart, Launceston.

The abdomen appears to vary slightly in ground colour. In two specimens there are lateral brown areas on all the segments; in some these brown areas are

confined to the first and second segments and in others the abdomen may appear uniformly blackish.

VILLA VELOX White.

Anthrax velox, White, *Proc. Roy. Soc. Tasm.*, 1916, 211; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 50.

♂. The head is black; the occiput is black, covered with black or dark brown scales; the frons is black, clothed with numerous black hairs and some brown scales near the antennae; the face is prominent, black, and covered with dense brown scales and black hairs, the brown scales are rather light, and in certain lights appear whitish; the antennae are entirely black, the third segment with a stout styliform portion, which ends in a minute spine; the proboscis is black, and generally slightly longer than the oral aperture.

The thorax is black, clothed dorsally with brown and black scales and hairs, and in front and on the sides with thick yellow-brown hairs, which are somewhat paler above the wing insertions; the scutellum is black with black and brown scales, the latter more or less confined to the margin, and bearing long black marginal bristles; the pleurae are also provided with yellow-brown hairs; the squamae are dark with a fringe of yellowish scales; the halteres are dark.

The abdomen is black, with dorsal black scales and hairs and brown and white scaly bands, the brown bands being on the second, third, fourth, and fifth segments and the white bands more prominent on the second and fourth; on each side of the basal segment there is a tuft of yellowish hairs which become dirty white on the second; the venter is black, clothed with brown and white scales and hairs.

The legs are brownish or black-brown covered with black and brown scales and hairs; the fore tibiae are sometimes provided with distinct though very minute spines.

The wings are hyaline, but not glistening, with the base and the costal border for two-thirds its length, dark brown; the colour includes the vein r-m, and tinges the apical portion of the median basal cell.

The female is similar.

Length of body, 8-11 mm.; of wing, 7-9 mm.

Hab.—Cradle Mt., Tasmania.

There are seventeen specimens in the collection of Mr. G. H. Hardy, all from the same locality, and another specimen in the Australian Museum also from Cradle Mt. White's description was taken from a male 13 mm. in length. No specimen in the series examined is as large, a single specimen being 11 mm. long, most of the others varying from 8-10 mm.

VILLA VITREA Walker.

Anthrax vitrea, Walker, *Ins. Saund. Dipt.*, 1850, 181; White, *Proc. Roy. Soc. Tasm.*, 1916, 208; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 49.

♂. The head is black; the occiput is black, with light brown or whitish scales, and some short black hairs; the frons is black, very narrow toward the head vertex and clothed above with erect black hairs, and below with dense silver white scales which become detached very easily; the face is lightly prominent, black, clothed with brown scales which have whitish reflections; the antennae are entirely black, the third segment with a slender styliform part, which ends in a

minute spine; the proboscis is black and stout and does not project beyond the epistoma.

The thorax is black, with thick yellowish or yellow-brown anterior and lateral hairs, the latter somewhat lighter above the wing insertions and dorsal black and brown scales and black hairs; the bristles are mainly yellow or brown; the scutellum is black, covered with brown and black scales and bearing black marginal bristles; the pleurae are provided with yellow or yellow-brown hairs; the squamae are blackish, though rather light, with a fringe of yellowish-white scales; the halteres are brown with yellow knobs.

The abdomen is black, with white bands on the second and fourth segments and brown bands on the other segments; the apex is covered with brown scales; the hairs on each side of the basal segment are yellowish or dirty white and extend as clearer white hairs to the posterior border of the second segment; the venter is black, clothed with black and brown scales and black hairs.

The legs vary somewhat from black to brown, and are covered with black and brown scales and black hairs; the fore tibiae are devoid of spines.

The wings are hyaline, light brown at the base and along the course of the closely adjacent veins, Sc and R_1.

In the series before me the females possess brown scales only on the lower half of the frons, the silver white scales seen in the male being apparently absent. I would like to see some more specimens before I record this as a sexual character, as these scales are very easily rubbed off, and are absent in many of the males.

Length of body, 6-8 mm.; of wing, 5-7·5 mm.

Hab.—Q'land: Brisbane, Stradbroke Is.; N. S. Wales: Sydney, Blue Mts., Collaroy; W. Australia: Perth; Tasmania: Hobart, Cradle Mt.

In his revision of the Bombyliidae of Tasmania, White recorded *Anthrax vitrea* as synonymic with *Anthrax minor*, but made no remarks concerning it. This species, *vitrea*, was described by White in his revision under the name *Anthrax nigricosta*, but I am satisfied that his identification of *nigricosta* was not correct, as the species he described as *simplex* agrees more readily with Macquart's description.

Villa brunea, n. sp.

♂. The head is black; the occiput is dull black with abundant brownish scales, which are somewhat more dense near the hind indentations of the eyes; the ocellar tubercle is black and prominent, crowned with a few erect black hairs; the frons is black, rather broad at the vertex, and clothed with dense black hairs and brown scales which are more conspicuous near the antennae; the face is conical, black, and densely covered with brown scales and some black hairs; the antennae are entirely black; the first segment is twice as wide at its apex as at its base, with the inner apical angle sharply acute, the whole being clothed with brown and black hairs; the second segment is about half as long as the first, bearing short black hairs; the third is longer than the first and second together, the basal discoidal portion about as long as the second segment, but not as wide; the styliform part is rather stout and has a minute spine at the apex; the proboscis is stout and black, and is concealed within the oral aperture; the hind indentation and the bisecting line of the eyes are both well marked.

The thorax is black, finely punctate, covered dorsally with brown scales and some whitish depressed hairs, and bearing in front and on the sides long, dense, light brown hairs; the bristles are rather weak, the pre-alars being yellowish and

the post-alars black; the scutellum is black, covered with brown scales and provided with black bristles on the margin; the pleurae are grey dusted and bear brownish hairs, which become somewhat whitish below the wing insertions; the squamae are yellowish with a fringe of white hairs; the halteres are also yellowish with pale knobs.

The abdomen is black, not as long as the head and thorax, with bands of white scales on the second and fourth segments and white scales on the apex; the remainder of the dorsum is covered with brown scales and some brown and black hairs; laterally there is a brown or dirty white tuft of hairs on each side of the basal segment, the hairs extending to the middle of the second segment; the other segments have traces of white scales on the sides; the venter is blackish, covered with white and brown scales and hairs.

The legs are black, covered with shining brown scales and brown and black hairs; the fore tibiae are provided with hairs only.

The wings are strong, hyaline and glistening, tinged brown at the base and along the course of the closely adjacent veins, Sc and R_1; the terminal loop of R_{2+3} is well developed; the median cell is rather broad, with r-m placed before its middle; R_4 possesses a small appendix; cell R_3 without an interradial crossvein.

Holotype male, Gravesend, N.S.W., 27th March, 1927, F. Roberts. Length of body, 7 mm.; of wing, 6·5 mm. The female is similar, with the eyes much farther apart at the head vertex.

Allotype female, Gravesend, N.S.W., 27th March, 1927, F. Roberts. Length of body, 6·5 mm.; of wing, 6 mm.

There are fifteen paratypes (8 ♂, 7 ♀) in the author's collection, all taken at Gravesend during March, 1927. The frons of the male is much broader than usual at the vertex, and is about twice or more than twice the width of the ocellar tubercle. Usually in the males of the genus, the eyes are separated at the vertex of the head by little more than the breadth of the ocellar tubercle. In the paratypes the venation is slightly variable, and appendices, especially on R_4, are present or absent; in one specimen, the appendix is produced so that a small rectangular extra cell is formed.

The holotype and allotype are in the Queensland Museum.

Villa trivincula, n. sp.

♀. The head is black; the occiput is black, covered with silvery white scales, which are more dense near the hind indentations of the eyes; the ocellar tubercle is black and prominent; the face is rounded, and is covered with silvery white scales which extend up the inner margins of the eyes for about half the depth of the frons, which is also black, and bears numerous erect black hairs; the antennae are entirely black, the first segment with stiff black hairs outwardly and long silvery white scales inwardly; the third segment has a rather thick styliform portion which has a minute apical spine; the proboscis is black and is concealed within the oral aperture; the hind indentations and bisecting line of the eyes are both well developed.

The thorax is somewhat shining black and is covered dorsally with shining black scales and black hairs; in front and on the sides the hairs are dense and white, and there are patches of almost golden hairs above the wing insertions; the bristles are well developed and black; the scutellum is black and is covered

with black scales and bears long, black, marginal bristles; the pleurae are blackish, rather bare, and provided with white and brown hairs; the squamae are light brown and have a fringe of short white scales; the halteres are dark.

The abdomen is black, longer than the thorax, practically straight sided and broadest at the sixth segment; the dorsum is covered with black scales and hairs, but on the anterior border of the second segment there is a narrow band of white tomentum, and on the posterior borders of the fourth, fifth, and sixth segments there are narrow bands of silvery white scales, which also cover the apex; the sides of the first, second and third segments bear long, dense, whitish hairs, which are longer and more dense on the first; the venter is black, and is covered with white and black scales and hairs.

The legs are mainly blackish, clothed with black scales and hairs; the femora have some white scales below and there are a few very minute spines on the fore tibiae.

The wings are hyaline, but light brown at the base and along the course of the closely adjacent veins, Sc and R_1; the bifurcation of R_{2+3} and R_{4+5} takes place opposite r-m; cell R_3 is undivided.

Holotype female, Brisbane, 13th November, 1923, L. Franzen. Length of body, 8·5 mm.; of wing, 8 mm. Allotype male, Sydney, 2nd February, 1919, G. H. Hardy. Length of body, 8 mm.; of wing, 7·8 mm.

The male is similar to the female, except for the width of the eyes at the head vertex.

Two paratypes are known, H. Hacker, Brisbane, 16th November, 1925, a male, and L. Franzen, Brisbane, 13th November, 1923, a female. The holotype, allotype, and paratypes are in the Queensland Museum.

Villa pellucida Walker.

Anthrax pellucida, Walker, *Ins. Saund. Dipt.*, 1854, 181; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 49.

♂. The head is black; the occiput is black, covered with brown or brownish-yellow scales, which are somewhat darker near the post-vertical furrow; the frons is slightly broader at the vertex than the ocellar tubercle, and is black, covered with dark brown scales and black hairs; the face is bluntly prominent, with similar dark brown scales, and somewhat depressed black hairs; the antennae are entirely black, the first and second segments being clothed with long and short black hairs; the third segment is subulate or elongate conical, and is furnished with a minute apical spine; the proboscis is black, and entirely concealed within the oral opening; the hind indentation of the eyes is rather weak, but the bisecting line is long and distinct.

The thorax is blackish, covered dorsally with dark brown scales and black hairs; the collar consists of stiff light brown or dirty white hairs, and on the shoulders are some clearer white hairs which extend to a point almost directly above the wing insertions; the bristles are well developed and black; the scutellum is blackish, covered with dark brown scales and bearing weak black bristles; the pleurae are furnished with sparse reddish hairs, the squamae are brownish with a brown fringe; the halteres are light brown.

The abdomen is black, and is covered dorsally with brown, white, and black scales, arranged in bands, and some black hairs; there are white bands on the anterior borders of the second and fourth, and brown bands on the second, medianly, the third, anteriorly, the fourth, medianly, and the fifth and sixth,

posteriorly; the apex is also provided with some white scales; on each side of the first segment the hairs are clear white and extend to the middle of the second segment, the remainder are provided with sparse black hairs; the venter is black, clothed with dark brown scales and black hairs.

The legs are mainly black, but are sometimes tinged brown, and are covered with brown scales and black hairs, the scales in certain lights having whitish reflections; the fore tibiae are provided with hairs only.

The wings are hyaline, but dark brown at the base and along the fore margin for two-thirds its length; the apex of the subcostal cell is hyaline or only faintly brown; the brown of the fore margin never descends to the bifurcation of veins R_{2+3} and R_{4+5}, though this bifurcation may sometimes be faintly tinged; the shoulders are provided with silvery white scales.

The female is similar.

Length of body, 3-6 mm.; of wing, 3·5-6·5 mm.

Hab.—Q'land: Brisbane, Peel Is.; N. S. Wales: Sydney, Woodford, Blue Mts., National Park (Gundamain); Tasmania: Hobart.

Hardy has recorded *pellucida* as a synonym of *nigricosta*. There is a single specimen of *pellucida* in his own collection from the type locality, Tasmania, and the discovery of other specimens from Queensland and New South Wales rather strengthens the distinctiveness of the two species.

Villa varipennis, n. sp.

♂. The head is black; the occiput is black, bearing brown scales, which become somewhat darker around the post-vertical furrow, which is well developed and deep; the ocellar tubercle is large, rounded, and black; the frons is black, covered with erect black hairs and brown scales, the latter being more conspicuous on its lower half; the face is prominent, black, and clothed with brown scales and black hairs; the antennae are entirely black; the first segment is covered with stiff black hairs and at the vertex is half as broad again as at the base, the inner apices almost touching; the second is short, about one-half the length of the first; the third is conical and, at the base, about as broad as the second, the whole being as long as the first two together, and gradually tapering so that at the apex it is half as broad as at the base; there is a distinct but minute spine; the proboscis is concealed within the oral aperture; the palpi are slender, brown, and fairly elongate; the eyes are separated at the vertex by about twice the width of the ocellar tubercle, and have a well developed hind indentation and bisecting line.

The thorax is black, finely punctate, and covered dorsally with dark brown and black scales, the brown scales apparently being more or less confined to a large basal area, from which they extend towards the head as two indistinct stripes; the anterior and lateral hairs are whitish or light brown; the bristles are rather weak and brown; the scutellum is black, covered with brown or reddish scales with which numerous black scales are mingled, and provided with thin brown marginal bristles; the pleurae are black, bearing brownish hairs; the squamae are obscure brown with a fringe of short white hairs; the halteres are light yellow with somewhat whitish knobs.

The abdomen is black, rather stout, as long as the head and thorax, and clothed with bright brownish scales and brown hairs; the basal segment has a thin white pubescent band, which extends laterally as a white tuft; the venter is black and is also covered with brown scales.

The legs are blackish, the fore tibiae brownish basally, and covered with brown scales; the fore tibiae are provided with hairs only.

The wings are broad, with a well developed lobe and alula; they are yellowish at the base, the rest of the wing being dark brown with a clearer apex; there is a greyish spot at the apex of the second basal cell; the cell R_3 is divided by a crossvein; R_{2+3} has a well developed terminal loop.

Holotype male, Gravesend, N.S.W., March, 1927. F. Roberts. Length of body, 5·5 mm.; of wing, 5 mm. Allotype female, Gravesend, N.S.W., March, 1927, F. Roberts. Length of body, 5·2 mm.; of wing, 4·8 mm.

The female differs from the male in the greater width of the frons at the head vertex, and in the colour of the wings, which are not dark brown, but somewhat smoky, with a clearer apex and hind margin.

There are thirteen paratypes (8 ♂, 5 ♀) in the author's collection, all taken at Gravesend in March, 1927, and five in the collection of Mr. J. Mann from Biniguy (November, 1923). In some of the specimens there are traces of white scales on the sides of the second, third, and fourth abdominal segments, and of an indistinct white scaly band across the fourth segment. In one specimen there is a small, triangular extra cell in cell R_3.

Villa aprica, n. sp.

♂. The head is mainly black; the occiput is black, covered with very small brown scales, which appear whitish in certain lights; the post-vertical furrow is well developed and deep; the frons is black, slightly broader than the ocellar tubercle at the vertex, and clothed with dense, erect, black hairs and brown scales, the latter more conspicuous on the lower half; the face is only slightly prominent, black, and covered with white scales, which are stained slightly yellow between the antennal base and the upper mouth borders, and more yellowish on each side; the ocellar tubercle is brownish and prominent; the antennae are entirely black, the first segment about twice as long as the second and bearing numerous white scales at its base, and long black hairs on its surface; the third segment is somewhat conical, but rather swollen at one-third from its base, not as broad as the second, but much longer than the first and second together, and provided with a minute apical spine; the proboscis is entirely concealed within the oral opening; the eyes possess a well developed hind indentation and a long and distinct bisecting line.

The thorax is blackish, and bears stiff anterior and lateral brownish hairs, and is covered dorsally with brown and black scales, the brown scales being more conspicuous immediately anterior to the scutellum, from whence they extend forward as three indistinct stripes; there is also a patch of brown scales placed above the wing insertions; the bristles are well developed and black; the scutellum is black, covered with black and brown scales, the brown scales being confined to the margin, which also bears well developed black bristles; the pleurae are furnished with tufts of brownish hairs, and beneath the wing insertions there are some soft white hairs; the squamae are dark, with a fringe of yellowish hairs; the halteres are tinged black, with yellowish knobs.

The abdomen is black-brown, almost parallel sided, about twice as long as its greatest width, with a truncated tip; there are bands of white scales on the anterior border of the second segment, which is broad and somewhat dilated laterally, on the anterior border of the fourth, the posterior border of the sixth, and on the apex; there are narrow brown bands on the second segment medianly,

the third anteriorly, and much broader bands on the posterior halves of the fifth and sixth; the remainder of the dorsum is covered with black scales, with some black hairs present apically; on each side of the basal segment are some soft, clear white hairs, which extend to the posterior edge of the white band on the second segment; the venter is brownish with some thin white pile basally, otherwise covered with brown scales and hairs.

The legs are mainly brownish, with the fore femora black for the basal two-thirds, and somewhat darker tibiae and tarsi, and are covered with black scales above and brown below; the fore tibiae are furnished with hairs only.

The wings are hyaline, but brown at the base and along the fore margin to the apex of the subcostal cell, the colour descending to the bifurcation of the veins R_{2+3} and R_{4+5}; R_{2+3} originates a little anterior to r-m; the contact of cell M_1 with the median cell is only half the contact of cell 2nd M_2; the cubital cell is broadly open; cell R_3 is undivided.

Holotype male, National Park (Gundamain), N.S.W., 14th February, 1926, I. M. Mackerras. Length of body, 10·5 mm.; of wing, 8·5 mm. Allotype female, National Park (Gundamain), N.S.W., 14th February, 1926, I. M. Mackerras.

The female is similar to the male.

There are seven paratypes (6 ♂, 1 ♀) in Dr. Mackerras's collection, all taken at Gundamain, National Park, Sydney, on 14th February, 1926.

There are two specimens (♂, ♀), collected by Mr. A. J. Nicholson at Woy Woy on 8th May, 1924, which are somewhat different from the holotype and allotype. In these two specimens, the hairs clothing the sides and front of the thorax are more whitish than brown, the fore femora are almost uniformly brown, and the femora of all the legs are covered beneath with white scales. They are also of much larger size. There is a much smaller male (Blackheath, 24th November, 1919) in the collection of Mr. G. H. Hardy, in which the face is mainly light brown in colour. The holotype and allotype are in the collection of the Macleay Museum.

I have seen three specimens which possess distinct, though minute, spines on the fore tibiae.

Villa nigricosta Macquart.

Anthrax nigricosta, Macquart, *Dipt. Exot.*, Suppl. 4, 1850, 111; Froggatt, *Austr. Ins.*, 1907, 296; White, *Proc. Roy. Soc. Tasm.*, 1916, 209; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 49.

♂. The head is mainly blackish; the occiput is blackish, bearing small, appressed, black hairs and brown scales, the latter appearing whitish near the hind indentations of the eyes; the frons is black, about once and one half the width of the ocellar tubercle at the vertex, and clothed with numerous black hairs and some brown scales; the face is prominent and black and bears dense brown scales and some black hairs; the antennae are entirely black, the first and second segments furnished with long and short, brown and black, and black hairs respectively; the third is somewhat subulate with a minute apical spine; the proboscis is black, with brownish labella, and rarely extends beyond the epistoma.

The thorax is blackish-brown, provided in front with stiff, dense, grey, hairs; there is a patch of white hairs on the shoulders and some brown, appressed hairs above the wing insertions; the dorsum is covered with brown scales and hairs, with white scales near the collar; the bristles are black; the scutellum is blackish with dorsal brown scales and black marginal bristles; the pleurae are grey dusted with reddish or red-brown hairs; the squamae are blackish or brownish, with a fringe of light brown scales.

The abdomen is black, covered with bands of white, brown, and black scales; the white scales occupy the first segment and the anterior border of the second, the middle of the fourth, the posterior border of the sixth and the larger portion of the apex, while the brown bands are placed on the posterior border of the second, the larger part of the third, the anterior border of the fourth, most of the sixth and a small part of the apex; on each side of the basal segment is a tuft of white hairs; the venter is brownish, covered with shining brown scales.

The legs are brownish, with somewhat darker tarsi, and covered with brown scales; the fore tibiae are provided with hairs only.

The wings are hyaline, light brown at the base and along the fore margin, the colour being generally confined to the costal and subcostal cells, with cell R sometimes faintly tinged.

The female is similar.

Length of body, 4-6 mm.; of wing, 3·5-5 mm.

Hab.—Q'land: Brisbane; N. S. Wales: Sydney; Victoria: Melbourne; Tasmania: Hobart, Launceston.

The species described by White as *nigricosta* is probably that described in this revision as *vitrea*, while his *simplex* may be the species I have identified as *nigricosta*.

Villa albata, n. sp.

♂. The head is mainly black; the occiput is black, covered with short, appressed, black hairs and white scales; the ocellar tubercle is black and prominent; the frons is jet black, narrow at the vertex, and bearing erect black hairs and brown scales, the latter more conspicuous on its lower half; the face is bluntly prominent, covered with brown scales and black hairs; the antennae are entirely black; the third segment is about twice as long as the first two together, its basal portion very broad and flattened, and the styliform part very slender, with a minute spine at the apex; the proboscis is short and black; the palpi are also black or very dark brown; the eyes have a rather weak hind indentation, but a long and distinct bisecting line.

The thorax is black, with long, dense, clear white hairs in front and on the sides, and white and brown scales and erect white hairs on the dorsum; the bristles are thin and brown; the scutellum is black, more triangular than semicircular in shape, covered with white and brown scales and furnished with thin, brown and blackish marginal bristles; the pleurae are provided with long white hairs, which become somewhat golden and much shorter below; the squamae are brownish, with a fringe of white scales; the halteres are light brown, with rather stout stalks.

The abdomen is black, about as long as the thorax, and covered with erect white hairs and white and brown scales; the first, second and third segments are covered laterally with dense, white hairs; the venter is black, covered mainly with brown scales.

The legs are blackish with brown tibiae, and are covered with white scales and hairs; the fore tibiae are provided with hairs only.

The wings are entirely hyaline and glistening; Sc and R_1 are contiguous or almost so; R_{2+3} originates from R_{4+5} well after r-m; the contact of cell M_4 with the median cell is almost equal to the contact of cell M_3; both cell R_5 and the cubital cell are broadly open.

Holotype male, Geraldton, W. Australia, 5th September, 1926, E. W. Ferguson. Length of body, 5 mm.; of wing, 5·2 mm. There are two paratypes in the collection of the late Dr. E. W. Ferguson with the same data. The holotype is in the Macleay Museum.

VILLA RAVA, n. sp.

♂. The head is black; the occiput is brownish-black, covered with light brown scales, which are somewhat whitish near the hind indentations of the eyes; the post-vertical furrow is well developed and deep and attains the prominent ocellar tubercle, which is black, and surmounted with a few erect black hairs; the frons is jet black, covered with erect black hairs and brown scales, the latter being more or less confined to its lower half; the face is black, slightly prominent, and covered with dense light brown scales and black hairs; the antennae are entirely black, the first segment being provided with stiff black, and brown hairs; the second is short, and bears short, black hairs; the third is as long as the first two segments together, somewhat subulate, with a rather stout styliform portion, and furnished with a minute spine at the apex; the mouth opening is normal, and the genae are linear; the proboscis is stout and black, with brownish labella, and is concealed within the oral aperture; the palpi are very slender and black; the eyes have a well marked hind indentation and a long and distinct bisecting line, and are separated at the head vertex by slightly more than the width of the ocellar tubercle.

The thorax is brownish-black, finely punctate, with brownish postalar calli, and is covered in front and on the sides with long brownish hairs, and on the dorsum with dark brown scales and long sparse light brownish pubescence; on each side, above the wing insertions there is a patch of very light brown hairs; the bristles are well developed and black; the scutellum is brownish, somewhat black at the base, covered with brown scales and bearing long, black, marginal bristles; the pleurae are provided with whitish and brown hairs; the squamae are brownish, with a fringe of white scales; the halteres are pale brown, with whitish knobs.

The abdomen is black, the two basal segments somewhat brownish laterally, and clothed with white and brown tomentum; there is a thick white pubescent band on the second segment, and bands of white scales on the fourth and sixth segments; the apex is also covered with white scales; the rest of the dorsum is provided with brown scales with some black hairs towards the apex; mingled with these brown scales are a few black scales; on each side of the basal segment is a tuft of soft, clear white hairs, which extend to the posterior border of the second segment; the other segments bear black and brown hairs laterally; the venter is blackish with sparse white pile and a subapical brown band.

The legs are black, covered with bright tawny scales; the fore tibiae are brownish beneath, and are provided with hairs only.

The wings are hyaline, but brown at the base and along the fore margin for two-thirds the length, the colour being dilated so as to cover the bifurcation of veins R_{2+3} and R_{4+5}; the apex of the median basal cell is also tinged brown; R_{2+3} originates from R_{4+5} opposite r-m.

The female is similar.

Holotype male, Chinchilla, Q'land, 3rd October, 1926, B. Smith. Length of body, 11 mm.; of wing, 11 mm. Allotype female, Chinchilla, 12th November, 1926, B. Smith. Length of body, 10 mm.; of wing, 11 mm.

There are five paratypes (2 ♂, 3 ♀) in the author's collection and a further eleven (5 ♂, 6 ♀) in the collection of Mr. B. Smith, all taken at Chinchilla, October to November, 1926. There are further specimens taken at the same locality in the collections of Messrs. T. Cole, and A. R. Taylor, of the Prickly Pear Station, Chinchilla.

Villa quinqueguttata, n. sp.

♀. The head is black; the occiput is black, covered with short, appressed black hairs, and brown scales, which appear whitish in certain lights; the ocellar tubercle is placed a little below the vertex of the head, is large and black, and crowned with a few erect black hairs; the frons is black, about three times the width of the ocellar tubercle at the head vertex, and is covered with erect black hairs, and brown scales, the latter being restricted to its basal half; the face is sharply conical, black, bearing brown scales and a few black hairs; the antennae are entirely black; the first segment is cylindrical and is covered with long, stiff, black hairs; the second is short, about one-third the length of the first, and clothed with short black hairs; the third segment is longer than the first and second together, unevenly conical, the inner surface being somewhat concave, and provided with a minute apical spine; the proboscis is black, concealed within the oral aperture; the eyes have a well marked hind indentation and a long and distinct bisecting line.

The thorax is black, with dorsal black and brownish scales, which have purplish reflections, and anterior and lateral stiff, greyish hairs; there are some whitish scales on the shoulders; the pre-alar bristles are black and brown and the post-alars are black; the scutellum is black, covered with black and brown scales and bearing black marginal bristles; the pleurae are provided with stiff, black, and brown hairs; the squamae are black, with a fringe of white scales; the halteres are brown.

The abdomen is blackish, somewhat conical, about as long as the thorax, with a band of white scales on the second segment; the remainder of the dorsum is covered with numerous brown and a few black scales, with some black hairs apically; laterally there is a tuft of white hairs on the first and the anterior half of the second segments; the venter is black, covered with brown scales and scattered black hairs; the brown scales covering the abdomen appear whitish in certain lights.

The legs are mainly brownish, clothed with black and brown scales and black hairs; the fore tibiae are provided with hairs only.

The wings are hyaline, with the base and two-thirds of the fore margin deep brown, leaving the apex of the subcostal cell hyaline; the brown covers the bifurcation of the veins, R_{2+3} and R_{4+5}, where it is dilated into a large darkened spot; there are four infuscations in the hyaline area, placed on the veins between the median cell and cell M_1, the median and cell M_2, M and M_4, and a larger spot near the origin of R_4; cell R_3 is divided by a crossvein.

Holotype female, Sydney, 8th December, 1918, G. H. Hardy. Length of body, 8 mm.; of wing, 8·5 mm.

There are five ♀ paratypes in the collection of Mr. G. H. Hardy, labelled Sydney, 8/12/18, 26/12/18, 24/11/19 (2), and Como 8/10/21 (G. H. Hardy). The holotype is in the Queensland Museum.

VILLA FUMEA, n. sp.

♀. The head is black; the occiput is dull black, covered with short black, appressed hairs and yellowish scales, which become silvery white near the hind indentations of the eyes; the post-vertical furrow is well developed and deep; the fringe of hairs at the border of the central cavity is whitish; the ocellar tubercle is dark brown; the frons is dull black, the face is bluntly prominent, and black, both frons and face bearing black hairs, which are more dense and erect on the frons, and dense yellowish scales; around the upper mouth borders are many yellow hairs; the antennae are entirely black; the first segment is about twice the length of the second and is covered with long black hairs; the third segment is slightly broader at the base than the second, quickly attenuated into a long styliform process, and provided with a minute apical spine; the proboscis is black, with large fleshy labella; the palpi are black; the eyes possess a well marked indentation of the hind borders and a long and distinct bisecting line.

The thorax is black, with stiff yellowish hairs in front, and a stripe of almost golden hairs on each side, these hairs being continued around the anterior part of the thorax, just below the collar; the dorsum is covered with black scales and hairs, and there are three indistinct stripes of brown scales, more conspicuous anteriorly; immediately anterior to the scutellum are some fine golden hairs; the bristles are well developed and black; the scutellum is black, covered with black and brown scales, and bearing long black marginal bristles; the pleurae are blackish, with brownish hairs, which become somewhat sparse and pale below the wing insertions; the squamae are dark brown, with a fringe of dark scales; the halteres are brown.

The abdomen is shining black, rather broad, as long as the thorax, with a truncated tip; on the anterior border of the second segment is a very narrow band of white scales, below which is a narrow band of brown scales; there is a broad band of white scales on the fourth segment, which is somewhat dilated laterally; the ultimate and penultimate segments are also covered with white scales; the rest of the dorsum is clothed with black scales and scattered black hairs; on each side of the basal segment are some dense, clear white hairs, which extend to the middle of the second segment; the genital spines are brown; the venter is covered with thin white pile, but the apex is broadly black pollinose.

The legs are black or blackish-brown, with the fore tibiae and hind femora somewhat lighter below; the coxae bear long, white hairs, and the rest of the legs are covered with black scales and hairs; the fore tibiae are devoid of spines.

The wings are brown at the base and along the fore margin, the colour gradually clearing to the apex and hind margin, leaving the wing smoky; there is a clear greyish spot at the apex of the median basal cell; cell R_3 without an interradial vein; cells Cu and R_5 are open.

Holotype female, National Park, Gundamain, 1/3/26, I. M. Mackerras, in the Macleay Museum. Length of body, 15 mm.; of wing, 15·5 mm.

There are three paratype females in the collection of Dr. I. M. Mackerras, all from Gundamain, National Park, dated 14/2/26.

VILLA ALBOBASALIS, n. sp.

♂. The head is black; the occiput is dull black, covered with short, appressed, black hairs and brown scales, which become somewhat whitish near the hind indentations of the eyes; the ocellar tubercle is black, prominent, and crowned with a few erect black hairs; the frons is black, faintly shining, covered with

erect black hairs and brown scales, which become rather dense and lighter in colour towards the antennae; the face is slightly prominent, with dense light brown scales and some black and brown hairs; the antennae are entirely black, with stiff black and brown hairs on the first segment; the third segment is subulate, as long as the first and second together, with a thin filiform portion and a minute apical spine; the proboscis is stout and black, and is concealed within the oral aperture; the eyes are separated at the vertex of the head by slightly more than the width of the ocellar tubercle, and possess a well marked indentation of the hind borders and a distinct bisecting line.

The thorax is blackish, covered dorsally with dark brown scales, and furnished in front and on the sides with long, dense, light brown hairs; the bristles are well developed and black; the scutellum is brownish-black, with black and brown scales, the latter more or less confined to the margin, and bearing long, black bristles; the pleurae are blackish, with long whitish-brown hairs; the squamae are brown, with a fringe of white scales; the halteres are brown with lighter knobs.

The abdomen is black, not as long as the head and thorax, with brownish lateral areas on segments two and three; there is a thick band of white scales and hairs on the first segment and the basal third of the second, a band of silvery scales on the fourth, which is very narrow medianly, and similar scales on the sixth and apical segments; there are narrow brown scaly bands on the second, medianly, the third, basally, and the fourth and fifth, apically; the rest of the dorsum is covered with black scales and scattered black hairs; the hair on the sides of the basal segments is dense and white, and extends to the posterior border of the basal white band, the sides of the other segments bearing sparse black hairs; the venter is covered with thin white pile, with an apical black band.

The legs are mainly black, covered with brown scales and black hairs; the fore tibiae are provided with hairs only.

The wings are hyaline and glistening, brownish at the base and for a short distance along the fore margin, the colour following the course of the closely adjacent veins Sc and R_1, leaving the apical half of the costal cell more or less clear; r-m is placed a little before the median cell; cell R_5 is very long and narrow, hardly broader at the apex than at the base; there is a patch of white scales on the wing shoulders.

Holotype male, Chinchilla, Q'land, November, 1926, A. P. Dodd. Length of body, 10 mm.; of wing, 10·5 mm.

There are five paratype males, collected by Mr. A. P. Dodd at Chinchilla during November, 1926, and a further paratype male in the collection of Mr. G. H. Hardy (Brisbane, 27/12/1920).

The holotype is in the Queensland Museum.

Villa simplex Macquart.

Anthrax simplex, Macquart, *Dipt. Exot.*, suppl. 2, 1847, 52; White, *Proc. Roy. Soc. Tasm.*, 1916, 212; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 50.

♂. The head is black; the occiput is blackish, covered with brownish scales, which become whitish near the hind eye indentations; the frons is black, covered with erect black hairs and brown scales, the latter more or less confined to its lower half; the face is black, prominent, bearing white scales and a few black hairs; the antennae are entirely black, the third segment somewhat conical and provided with a minute apical spine; the proboscis is black and is concealed

within the oral aperture; the eyes are separated at the vertex by slightly more than the width of the ocellar tubercle and have a well marked indentation of the hind borders and a long and distinct bisecting line.

The thorax is blackish, covered dorsally with dark brown scales and a few black hairs, and bearing in front and on the sides, white or greyish hairs; the bristles are black, though rather weak; the scutellum is black, covered with dark brown scales and furnished with weak, black marginal bristles; the pleurae are blackish, with stiff, whitish or brownish hairs; the squamae are light brown with a fringe of white scales; the halteres are brown.

The abdomen is black, with bands of white scales on the second and fourth segments, and narrow bands of brown scales on the second, fourth, fifth and sixth segments; the apex is covered with white scales; the remainder of the dorsum is clothed with black scales and scattered black hairs; the venter is black, covered with brown scales and black hairs; on each side of the basal segment are some dense, whitish or yellowish hairs.

The legs are black or dark brown, the femora being somewhat brownish beneath; they are covered with brown scales and black hairs; the fore tibiae are provided with hairs only.

The wings are hyaline but brown at the base and along the fore margin, leaving the apical third of the costal cell almost clear, the colour being bounded below by the vein R_1.

Length of body, 4-7 mm.; of wing, 3·5-6 mm.

The female is similar.

Hab.—Q'land: Brisbane, Dunwich; N. S. Wales: Sydney; Tasmania: Hobart.

This species is apparently very variable in the colour of the hairs of the pleurae and at the sides of the first segment of the abdomen. In some specimens the hairs on the pleurae are clear white and in others, almost reddish, while the hairs at the base of the abdomen are white or yellow. The species may easily be distinguished from others of a similar size by the white scales on the face.

Villa argentipennis White.

Anthrax argentipennis, White, *Proc. Roy. Soc. Tasm.*, 1916, 212; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 48.

♂. The head is mainly black; the occiput is grey dusted, covered with short, appressed, black hairs and brown scales, which are whitish near the hind indentations of the eyes; the frons is black, covered with erect black hairs and brown scales; the face is black, bluntly prominent, and is also covered with brown scales, with some brown hairs along the upper mouth borders; the antennae are entirely black, the third segment unevenly conical, being concave inwardly, and with a minute apical spine; the proboscis is black, and is concealed within the oral aperture; the eyes are separated at the vertex of the head by slightly more than the width of the ocellar tubercle, and have a well marked hind indentatiton and a distinct bisecting line.

The thorax is brownish-black, with anterior and lateral light brown or dirty white hairs, those on the sides being somewhat lighter in colour; the bristles are well developed and black; the scutellum is brownish-black, covered with brown scales and bearing long black, marginal bristles; the pleurae are furnished with brown or reddish hairs; the squamae are brownish with a fringe of white scales.

The abdomen is brownish-black, with dense, long, white hairs on the sides of the first and second segments; there are bands of white scales on the second, fourth

and sixth segments, and bands of brown scales on the second, third, fourth and fifth segments; the apex is provided with white scales.

The legs are mainly brownish, covered with brown scales and black or brownish hairs; the fore tibiae are devoid of spines.

The wings are hyaline and glistening, and are deep brown at the base and along the fore margin, the brown being expanded from the base to colour most of cell R; cells Cu and R_5 are broadly open.

The female is similar.

Length of body, 6 mm.; of wing, 5·8 mm.

Hab.—Tasmania: Bagdad, Wedge Bay.

I have only seen two specimens of *argentipennis*, and they are both in the collection of Mr. G. H. Hardy, a male and a female.

Genus Lepidanthrax Osten-Sacken.

Lepidanthrax, Osten-Sacken, *Biol. Cent. Amer., Dipt.*, 1886, 107.

Genotype, *Anthrax disjuncta* Wied. by Coquillet's designation, 1910.

The head is large and globular; the frons is broad in both sexes; the face is large between the upper mouth borders and the base of the antennae; the antennae are widely separated at the base, and are inserted near the inner borders of the eyes; the third segment is onion-shaped, with a long filiform style, and a minute apical spine; the proboscis is considerably longer than the oral opening, and generally projects forward.

The thorax is quadrate, broadest behind, and furnished with well developed pre- and post-alar bristles; the scutellum is semicircular in shape, appressed, and provided with marginal bristles.

The abdomen is similar to that found in *Villa*, though its sides are fringed mainly with scales.

The legs are slender, the fore tibiae sometimes being provided with minute spines; pulvilli are absent; the claws are without a basal tooth.

The wings have the typical venation of the Exoprosopinae, but the contact of cell M_4 with the median cell is sometimes much longer than found in *Villa*; cells Cu and R_5 are always open.

Range.—Europe, Southern Asia, North and South America, North and South Africa, and Australia.

There are two species which fall into this genus, *linguata*, from Queensland and New South Wales and *albifrons* from South Australia, both being new. There is a third species, as yet undescribed, in the collection of the Macleay Museum. All these species agree in the main characters with Osten-Sacken's description of the genus, except that in none of them are the fore tibiae provided with spines, and the contact of cell M_4 with the median cell is not especially long, though it is sometimes longer than usually found in *Villa*.

These species were recorded by Hardy in the genus *Cytherea*, but as I mentioned before, this genus bears a much closer affinity to the Bombyliinae than to the Exoprosopinae.

Key to the Species of Lepidanthrax.

1. Face conical, covered with brown scales ..... *linguata*, n. sp.
   Face not so conical, covered with white scales ..... *albifrons*, n. sp.

Lepidanthrax linguata, n. sp.

♂. The head is black; the occiput is black, covered with brown scales, which appear whitish in certain lights; the post-vertical furrow is deep, but not very

long; the ocellar tubercle is prominent, blackish, and crowned with a few erect black hairs; the frons is black, about twice the width of the ocellar tubercle at the vertex, and covered with erect black hairs, and brown scales, which are more conspicuous on its basal half; the face is prominent, black, and covered with brown scales and some black hairs; the antennae are entirely black, the first segment broadest at the apex and provided with long stiff black hairs; the second is short, globular, and bears short black hairs; the third is about one and one-half times as long as the first two together, the discoidal portion being longer than the second segment, and of an equal width; the mouth opening is rather broad; the proboscis is slender, black, and projecting forward, being about twice the length of the oral opening; the palpi are blackish.

The thorax is of a faintly shining black, covered dorsally with brown and black scales, and in front and on the sides with long, dense, brownish or yellowish hairs; the bristles are black; the scutellum is black, with brownish scales and black marginal bristles; the pleurae are blackish, with brown and black hairs; the squamae are brown, with a fringe of dirty white or light brown scales; the halteres are an obscure light brown, with lighter knobs.

The abdomen is black, about as long as the head and thorax; there is a basal band of white scales, the rest of the dorsum being covered with brown scales with a few erect black hairs apically; on each side of the basal segment are some dense, dirty white, hairs, which extend to the middle of the second segment; the venter is black, covered with brown scales; the genitalia are brownish.

The legs are mainly blackish, the fore tibiae being brownish at their base, and are covered with brown scales and black hairs; the fore tibiae are provided with hairs only.

The wings are hyaline and glistening, faintly brown at the base and between the veins Sc and R_1; the terminal loop of the vein R_{2+3} is well developed; cell R_5 is long and narrow, about twice as wide at the wing margin as at the base; r-m is placed at about the middle of the median cell, with the origin of R_{2+3} just anterior to it; R_{2+3} is provided with a small appendix near its origin.

The female is similar.

Holotype male, Brisbane, Q'land, 21/11/26, F. Roberts. Length of body, 4 mm.; of wing, 3·5 mm. Allotype female, Brisbane, Q'land, 22/11/26, F. Roberts. Length of body, 3·5 mm.; of wing, 3 mm.

There are sixteen paratypes (10 ♂, 6 ♀) in the author's collection, all taken at Brisbane between 12th November and 2nd December, 1926. There is a further paratype female in the possession of Dr. I. M. Mackerras (National Park, 1/3/26). In the collection of the late Dr. Ferguson there are two further specimens from Cassilis, N.S.W. The holotype and allotype are in the Queensland Museum.

Lepidanthrax albifrons, n. sp.

♀. The head is mainly blackish; the occiput is grey dusted, and is completely covered with dense white scales; the frons is blackish, clothed with dense white and brown scales, the latter confined to the upper half; the face is black, not conical, but more or less bluntly prominent, and covered with dense white scales, which are stained somewhat yellowish between the upper mouth borders and the antennae; the antennae are blackish; the first and second segments are provided with long and short black hairs respectively; the third is about twice as long as the first two together, with an extremely slender styliform portion; the ocellar tubercle is brownish, rounded, and prominent; the proboscis is black and slender,

not quite twice the length of the oral aperture; the eyes are separated at the vertex by about three times the width of the ocellar tubercle, and possess a well developed hind indentation and a distinct bisecting line.

The thorax is blackish-brown, covered dorsally with brown and black scales; in front there are some long, stiff, brownish hairs, behind which are some stiff, white hairs; on each side and above the wing insertions is a stripe of appressed, white hairs, which extend from the post-alar calli to the stiff white hairs in front; immediately anterior to the scutellum is a small patch of white hairs, which, when intact, may meet the white stripe of the sides; the bristles are black, those on the post-alar calli being rather long; the scutellum is blackish-brown, covered with brown scales and bearing black marginal bristles; the pleurae are covered with white scales below, and sparse white hairs above; the halteres are dark.

The abdomen is somewhat broad, widest medianly, and covered with white, brown and black scales; on the anterior third of the second segment is a band of white scales, and there are similar scales on the sides of the other segments and on the apex; the dorsum is otherwise covered with brown and a few black scales and hairs; on the sides of the basal segment the hairs are yellowish and on the second segment, white; the venter is covered with some dirty white scales, with some clearer white pile basally.

The legs are mainly brownish, with darker tibiae and tarsi; the femora appear to be covered with brown scales above and white below; the tibiae are covered with brown scales only; the fore tibiae are devoid of spines.

The wings are dull hyaline, tinged brown at the base and between the veins Sc and R_1; the fore margin is somewhat greyish; r-m is placed before the middle of the median cell, with the origin of the vein R_{2+3} just anterior to it; cell R_5 and the cubital cell are broadly open.

Holotype female, Pearson's Island, Sth. Australia, Campbell. Length of body, 7 mm.; of wing, 6·5 mm. Allotype male, Pearson's Island, Sth. Australia, Campbell. Length of body, 6·5 mm.; of wing, 6 mm.

In the male the proboscis is longer than that of the female, being easily twice the length of the oral aperture.

No paratypes are known.

Both the holotype and allotype are not in the best condition, the abdomen in the male being almost entirely rubbed, while that of the female, though in much better condition, makes it very doubtful as to the extent of the white scales on the third, fourth, fifth and sixth segments.

The holotype and allotype are in the South Australian Museum.

Genus Pseudopenthes, n. gen.

Genotype, *Pseudopenthes fenestrata*, n. sp.

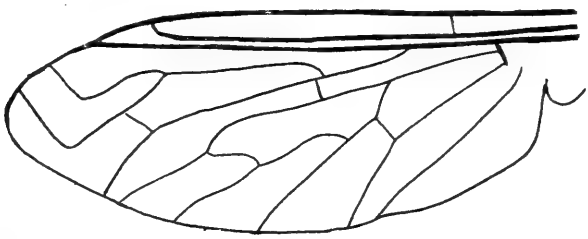
The head is large and globular; the ocellar tubercle is rounded, not very prominent, placed well below the head vertex; the frons is comparatively broad in both sexes; the face is conical, or sharply prominent and, like the frons, is covered with dense hairs and scales; the antennae are moderately stout; the first segment is cylindrical, the second short and globular, and the third somewhat conical and rather stout, longer than the first and second together, with a minute apical spine; the proboscis is hardly longer than the oral opening, though its tip is sometimes visible; the palpi are slender.

The thorax is quadrate, with rather weak pre- and post-alar bristles; the scutellum is large, depressed, with weak marginal bristles; the squamae are large, with a fringe of scales.

The abdomen is not very broad, somewhat parallel sided, covered mainly with scales.

The legs are slender, the fore tibiae being sometimes provided with distinct spicules; the claws of the intermediate and posterior tarsi are furnished with a long and acute basal tooth.

The wings are strong, with well developed lobes and alulae; cell R_3 is divided by a crossvein; cell 2nd M_2 is very long and rather narrow; cell R_5 and the cubital cell are open; the vein Cu_2 is incomplete.



Text-fig. 4. Wing of *Pseudopenthes fenestrata*, n. sp.

Pseudopenthes apparently links together the genera *Villa* and *Exoprosopa*. As in *Exoprosopa*, the frons is comparatively broad in both sexes, the ocellar tubercle is placed well below the vertex of the head, the third antennal segment is stoutly conical, cell R_3 is divided, and the claws have a long and acute basal tooth. It differs from *Exoprosopa* and approaches *Villa* in the character of the style, which is represented by a minute bristle. It is also related to the African genus *Littorhyncus*, and the American genus *Stonys*. From the former it may be distinguished by the convexity of the face and the possession of an interradial vein in cell R_3 and from the latter by the basal tooth of the claw.

PSEUDOPENTHES FENESTRATA, n. sp.

♂. The head is black; the occiput is shining black, covered with numerous appressed black hairs and dense white scales, which are more or less concentrated near the hind indentations of the eyes; the ocellar tubercle is black, rather large, and crowned with a few erect black hairs; the frons is shining black, covered with erect, black hairs, and numerous white scales, more conspicuous on its lower half; the face is black between the upper mouth borders and the antennae, otherwise brownish, and clothed with white scales and black hairs; the first segment of the antennae is somewhat brownish, bearing long, stiff, black hairs; the second segment is black, about one-third as long as the first, bearing short black hairs; the third is black, slightly longer than the first and second segments together. The mouth opening is rather broad; the proboscis is black, with the tip protruding beyond the epistoma.

The thorax is shining black, finely punctate, and covered on the dorsum with shining jet black scales; the hairs in front and on the sides are white, the latter appearing as a distinct stripe, when contrasted with the scales of the dorsum and the black hairs of the pleurae; the bristles are black; the scutellum is somewhat brownish, covered with black scales; on the margin are some white scales and black bristles; the squamae are black, with a fringe of white scales; the halteres are brownish with lighter knobs.

The abdomen is black, as long as the head and thorax together, and is covered mainly with black scales; on the anterior border of the second segment is a very narrow band of white scales, somewhat yellowish medianly, and on the sides of the third, fourth and fifth segments are small areas of similar scales, those on the third segment being rather larger; the apex is also covered with white scales; on each side of the first segment are some soft, dense, white hairs; the venter is brownish, covered with black and white scales, the latter not very numerous and more conspicuous towards the apex.

The legs are black-brown, covered with black scales and hairs; the fore tibiae are provided with hairs only.

The wings are mainly dark brown, almost black, with portions of the median basal and cubital cells and the lobe hyaline; the colour is deepest around the veins, leaving a small clearer area in the interior of each cell.

The female is similar.

Holotype male, Brisbane, 27th October, F. Roberts. Length of body, 10·5 mm.; of wing, 11 mm. Allotype female, Goodna, Q'land, 20/11/25, J. Mann. Length of body, 12 mm.; of wing, 11·5 mm.

There are six paratypes in the author's collection, 4 ♂, 2 ♀, from Brisbane, and Stradbroke Is., Q'land, and Gravesend, N.S.W. There are also three paratypes in the collection of Mr. J. Mann from Brisbane. This species is well represented in various collections, and has been taken at Woy Woy, Camden, and the Darling River, N. S. Wales; there are specimens in the collection of the Macleay Museum labelled South Australia.

In three of the paratypes there are distinct, though minute bristles on the fore tibiae, and the wings are uniformly blackish.

The holotype and allotype are in the Queensland Museum.

Among the material examined I have not been able to recognize *Anthrax flaveola* Macquart, *Anthrax resurgens* Walker and *Exoprosopa bicellata* Macquart. In case these three species should be discovered, I am appending the original descriptions.

VILLA FLAVEOLA Macquart.

Anthrax flaveola, Macquart, *Dipt. Exot.*, suppl. 4, 1850, 109; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 51.

"Nigra, flavo-hirta. Abdomine segmentis, 4.°-5.° que lateribus nigra pilosis. Alis hyalinis.

"Long. 6 l. ♂. Voisin de l'*A. flava*. Face à poils jaunes. Front à duvet d'un jaune plus fonce et petits poils noirs. Antennes noires. Thorax (un peu dénudé), à poils jaunes laissant voir des bandes longitudinales. Abdomen à fourrure jaune (dénudé au bord postérieur des segments); une touffe de poils noirs sur les côtés des quatrième et cinquième; quelques poils noirs mêlés aux jaunes, au bord postérieur des mêmes; septième terminé par des poils noirs; ventre à poils d'un jaune plus clair. Pieds noirs. Cuisses à duvet jaune. Ailes hyalines; côté jaunâtre; nervures normales. De la Nouvelle-Hollande, côte orientale".

There is a specimen in the collection of Dr. I. M. Mackerras, taken at Lake Barrine, North Queensland, which conforms somewhat to this description. The abdomen is rather rubbed, and its identification is very doubtful. However, it is the only specimen of *Villa* that I have seen approaching Macquart's description.

VILLA RESURGENS Walker.

Anthrax resurgens, Walker, *List Dipt. Brit. Mus.*, 1849, 259; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 49.

"Nigra, abdomine maculis quatuor ferrugineis, subtus fulvo, pedibus fulvis, genubis tarsisque piceis, alis limpidis, ad costum flavo-fuscis".

Body black; head wanting; sides and fore border of chest clothed with pale tawny hairs, which are more thick on the hoary breast; abdomen clothed with yellow hairs, tawny beneath, and having two large ferruginous spots on each side of the second and third segments; legs tawny, clothed with yellow hairs and black bristles; knees and feet piceous; wings colourless, yellowish-brown at the base and along the fore border till near the tips; wing ribs and veins piceous, the latter black towards their tips; poisers tawny with yellow tips. Length of the body about 6 lines; of the wings 14 lines.

"Swan River".

It is possible that *resurgens* is a synonym of *obscura*, but I am not at all certain on this point.

VILLA BICELLATA Macquart.

Exoprosopa bicellata, Macquart, *Dipt., Exot.*, suppl. 2, 1847, 51; White, *Proc. Roy. Soc. Tasm.*, 1916, 206; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 51.

"Nigra, rufo tomentoso. Alis fuscis hyalino maculatis, duabus cellulis marginalibus. Tab. 2, fig. 2.

"Long, 5½ l. ♂. Face conique, d'un fauve rouge, ainsi que la moitié antérieure du front; la postérieure d'un brun noirâtre. Antennes noires; premier article épais, à duvet fauve. Ecusson (dénudé) brunâtre, à base noire. Abdomen (en partie dénudé); côtés des deux premiers segments à poils fauves; ceux des autres à poils noirs, mêlés de fauves; deuxième à petite tache fauve de chaque côté. Pieds d'un fauve assez clair; jambes antérieures à extrémité noire; tarses noirs. Balanciers bruns. Ailes d'un brun noirâtre; deux cellules sous-marginales; discoïdale appendiculée; une grande tache d'un fauve brunâtre vers le milieu du bord extérieur; deux petites taches noires à la base des premières sous-marginale et postérieure; une petite tâche blanchâtre à la base de la discoïdale; une bande ou une petite tache hyaline au centre des marginales, des postérieures et de la discoïdale.

"De la Tasmanie".

Subfamily ANTHRACINAE.

The occiput is raised, bilobate above and with a central cavity; the hind borders of the eyes are indented and the bisecting line is usually long and distinct. The third segment of the antennae bears a distinct style which terminates in a pencil of hairs. The venation is the same as that encountered in the Exoprosopinae. Pulvilli are always present, though usually rather weak.

The subfamily contains a solitary genus *Anthrax*. *Spongostylum*, which occurs in Africa and America, is also placed here, but as far as an examination of two species received from South Africa will permit, I can determine no outstanding characters for the distinction of the two genera. The third segment of the antennae is broader than the second in *Anthrax* and not quite so in *Spongostylum*. In *maculata* and *incompta* the third antennal segment conforms to the type found in *Anthrax*, while in *angularis* and *confluensis* it is of the type found in *Spongostylum*. *Spongostylum*, according to Williston and Brunetti, is

also supposed to have an interradial vein in cell R_3 always present. In *maculata* this crossvein is sometimes present, but generally absent. The character of the comparative widths of the second and third antennal segments is certainly not to be reckoned generic and therefore it seems that *Spongostylum* and *Anthrax* should be considered synonymic.

Genus Anthrax Scopoli.

Anthrax, Scopoli, *Ent. Carl.*, 1763, 358.—*Argyramoeba*, Schiner, *Wein. Entom. Monatschr.*, iv, 1860, 51; White, *Proc. Roy. Soc. Tasm.*, 1916, 213; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 50, and 1923, 76.

Genotype, *Musca anthrax* Schrank, by original designation.

The head is globular in shape and generally a little broader than the thorax; the eyes are wide apart in both male and female; the ocelli are placed on a rounded prominence at or close to the head vertex; the frons is slightly raised between the eyes; the face is never prominent, both face and frons being clothed with dense hairs; the antennae are small, the third segment more or less onion-shaped, sometimes with a produced margin to be broader than the globular second segment; the style is distinct and typical of the subfamily; the mouth opening is short and very broad and contains the short stout proboscis.

The thorax is somewhat quadrate, more or less flattened, and is provided with dense hairs in front and on the sides; the metapleurae are bare; the squamae are well developed and provided with a fringe of hairs; the halteres are slender; the scutellum is rather large, depressed and somewhat semicircular in shape; the bristles on the thorax and scutellum are rather weak.

The abdomen is rather short and stout, flattened below, but rounded above, broadening posteriorly and with a pointed apex; the whole is covered with dense pubescence which is longest on the sides; the genital spines of the Exoprosopinae are replaced by long hairs.

The legs are of medium length, slender and with weak spines on all the tibiae; the fore femora are usually provided with long hairs only; pulvilli are present, though not strongly developed.

The wings are stout and strong, usually with a broad black pattern and sometimes with infuscated spots at the crossveins and bifurcations; the venation is that found in the Exoprosopinae; R_4 is usually provided with one or two appendices which may be continued to divide cells R_3 and R_4; cell R_5 is always broadly open and the cubital may sometimes be closed at the wing border.

Range.—World-wide.

As far as is known the genus in Australia comprises eight species, three of which are regarded as new. They are small to medium-sized Bombylids, usually with silver-white scales on the apex of the abdomen and with wings that generally have a broad black pattern, sometimes provided with numerous infuscated spots on the disc. In the bush they are usually to be found flitting about logs and stumps charred by fire. As the genus is apparently parasitic on Hymenoptera, the charred logs are attractive as they are used by various bees and wasps for their nests. Some species, particularly *angularis*, *confluensis* and *maculata*, may be seen flying about houses and other structures frequented by mud-building wasps. From the mud cells of the Eumenid, *Abispa splendida*, and of the Sphegid, *Sceliphron laetum*, *angularis* has been successfully bred; *incisa* and *incompta* from the cells of another Eumenid genus, *Odynerus;* and *maculata* from the nest of the native bee, *Trigona carbonaria*. An interesting life history has

lately been found for *confluensis*. The species has frequently been seen attempting to oviposit on the mud cells of several house-haunting wasps, though several attempts to obtain the fly from these cells were not successful. Mr. L. Franzen of Brisbane, some short time ago, brought before the Entomological Society of Queensland a specimen of this species which he had obtained from the cocoon of a Myrmeleontid—a very interesting and puzzling life history which is not at all easy to explain, as the species, like the other members of the genus, is very probably parasitic on Hymenoptera as well.

The genital spines possessed by the Exoprosopinae are replaced in *Anthrax* by dense long hairs. The egg is apparently laid on the outside of the nest or cell and the larva is provided with a boring apparatus, by means of which it is able to reach the host within.

Distribution.—Only one species, *maculata*, is known to occur in Tasmania. It extends as far north as Cape York, but is as yet unrecorded from Western Australia. The Western Australian species are limited to two, *incompta* and *angularis*, both of which extend into northern Queensland, *incompta* being extra-limital, as it is known from the Bismarck Archipelago; *incisa* occurs from Adelaide to Central Queensland, and *concisa* and *confluens* appear limited to Queensland and New South Wales. Both *lepidiota* and *ater* are known from Queensland only, the former from the south-western corner and the latter from the north.

Key to the Species of Anthrax.

1. Wings hyaline, but brown at the base and along the fore margin only 2
   Wings with a broad black pattern, the hyaline area being sometimes much reduced by spots and blotches 3
2. Wings spotted; a small species ..... *lepidiota*, n. sp.
   Wings not spotted; a large species ..... *angularis* Thomson.
3. Wings with the black pattern including the apex ..... *ater*, n. sp.
   Wings with the apex not uniformly black 4
4. Wings spotted or blotched 5
   Wings not spotted or blotched 7
5. Cell R_3 divided by a crossvein; R_4 with two complete branches; the apical half of the wing contains many confluent blotches and small smoky areas .. *confluensis*, n. sp.
   Cell R_3 sometimes with a crossvein; R_4 at most with an appendix; the apical half of the wing contains many clearly defined spots, which may be confluent, but never blotchy 6
6. The black pattern of the wing more or less confined to the basal half; hind border of wing without spots ..... *incompta* Walker.
   The black pattern occupying more than half the wing; hind border of wing with numerous spots ..... *maculata* Macquart.
7. Wings with axillary lobe mainly clear ..... *angularis* Thomson.
   Wings with axillary lobe black 8
8. The outline of the black area of the wing is angulated near the costal border ..... *concisa* Macquart.
   The outline of the black area of the wing is not angulated but is somewhat irregular ..... *incisa* Macquart.

ANTHRAX MACULATA Macquart.

Anthrax maculata Macquart, *Dipt. Exot.*, suppl., 1, 1846, 112.—*Anthrax diana*, Walker, *List Dipt. Brit. Mus.*, 1849, 252.—*Anthrax australis* Walker, *Ins. Saund. Dipt.*, 1850, 193.—*Argyramoeba maculata* White, *Proc. Roy. Soc. Tasm.*, 1916, 213; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 50, and 1923, 76.

♂. The head is black; the occiput is somewhat grey dusted, and bears numerous short, depressed, black hairs and some white scales; the face and frons are black, both covered with dense black hairs; the antennae are entirely

black, the third segment broader than the second and somewhat onion-shaped, the proboscis is black; the eyes have a well developed indentation at their hind borders and a long and distinct bisecting line.

The thorax is blackish and is furnished with stiff greyish and black hairs in front and on the sides; the dorsum is covered with upright black and appressed cuprous or brownish tomentum; the bristles are black; the scutellum is blackish-brown, covered with black and brownish scales and provided with long, thin, marginal bristles; the squamae are dark with a white fringe.

The abdomen is black, with the apex covered with silver white scales; on each side of the posterior border of the second segment there is a narrow strip of white tomentum; the rest of the dorsum is covered with black scales and hairs; on each side of the basal segment is a tuft of soft white pile and the sides of the remaining segments (except the apical ones) are provided with dense, long, black hairs.

The legs are black or black-brown and are covered with black scales and hairs.

The wings have a broad, black, irregular pattern, whose inner margin is almost dilated into two distinct spots near the hind border of the wing, and into a large, very irregular, indented area, reaching almost across the wing; along the hind margin of the wing are four isolated or partly isolated spots; the cubital cell may be closed at the wing margin.

The female is similar.

Length of the body 7·5-10 mm.; of the wing 8-10·5 mm.

Hab.—Queensland: Cape York, Marwood, Meringa, Pt. Denison, Pt. Curtis, Yeppoon, Brisbane, Stradbroke Is.; N.S. Wales: Sydney, Piper's Flats, Hay, Barrington Tops, Mt. Kosciusko; Tasmania: Cygnet, Georgetown, also from South Australia.

The vein R_4 has a rather deep dip into cell R_3 and from this dip there is usually a short downwardly projecting appendix. This appendix never becomes a complete interradial vein so cell R_4 is never divided. There is another stump present near the bifurcation of R_{4+5}, but this appendix is occasionally continued to meet R_{2+3}, so that cell R_3 becomes divided.

The spots on the wing are sometimes completely isolated, but in various specimens they have become wholly or partly confluent. In a male from Meringa this confluency has been carried to such an extent that the wings are wholly brown except for the apex and small areas between the spots on the hind margin.

Anthrax lepidiota, n. sp.

♀. The head is grey-black; the occiput is grey-black, covered with bronze scales and with light brown hairs bordering the central cavity; the post-vertical furrow is well developed and deep; the ocellar tubercle is rounded, somewhat sunken, but prominent; the antennae are entirely black; the first segment, at its apex, is about twice as wide as at the base, the second is extremely short and the third is longer than the first two segments together; at the base, the third segment is slightly broader than the second and bears a style of about one-quarter its length; the frons is slightly concave above, but near the antennae becomes raised, blackish-brown, but grey along the inner eye margins, and covered with erect black hairs and brown scales; the face is blackish, becoming grey towards the cheeks, and also has black hairs and brown scales.

The thorax is black and bears distinct bronze scales on the dorsum and is provided in front and on the sides with whitish hairs, those placed laterally forming a not well defined stripe; the bristles are black; the scutellum is black covered with brownish scales and bearing long, black, marginal bristles; the pleurae are black with a few golden hairs; the squamae are dark with a white fringe; the halteres are brownish with lighter knobs.

The abdomen is blackish, not as long as the head and thorax, with dorsal brownish or bronze scales and a few black hairs; on each side of the second and on the apical segments are some white scales; on each side of the basal segment is a tuft of white hairs; the venter is dark with shining scales.

The legs are brownish with somewhat darker tarsi and are covered with shining brown scales and brown and black hairs; the pulvilli are brownish.

The wings are dull hyaline, brown at the base and along the fore margin, the brown descending to cover the apex of the median basal cell and again, but more anteriorly, the bifurcation of R_5; there are two small brown spots on the veins between the median and cell M_3 and the median and cell M_1, and a larger spot at the origin of R_1; both R_4 and R_{2+3} have long appendices and R_{2+3} has a well developed terminal loop.

Holotype female, Chinchilla, Queensland. November, 1924. T. A. Cole. Length of the body, 8·5 mm.; of the wing, 9 mm.

The holotype is unique and is in the Queensland Museum.

Anthrax confluensis, n. sp.

♂. The head is black; the occiput is grey dusted and somewhat whitish near the indentations of the hind eye borders and covered with short black hairs; the post-vertical furrow is deep and attains the ocellar tubercle, which is rounded, prominent and black; the frons and face are black, covered with dense short black hairs; the antennae are entirely black, the first segment rather stout and covered with stiff black hairs, the second short, and the third longer than the first and second together, but with the basal discoidal part not as broad as the second segment; the style measures about one-fourth the length of the third segment; the proboscis is black; the palpi are black; the eyes have a well developed hind indentation and a long and distinct bisecting line.

The thorax is blackish, covered dorsally with black and brownish scales and erect black hairs; the hairs in front are mainly grey and those on the sides black; the bristles are black, not very strong; the scutellum is blackish covered with black scales and provided with black marginal bristles; the pleurae bear stiff blackish hairs; the squamae are blackish with a fringe of white hairs; the halteres are black with lighter knobs.

The abdomen does not broaden posteriorly as much as in the other species, the sides being gently curved; the apex is pointed and is covered with silver-white scales; except for a narrow interrupted white band on the posterior border of the second segment, the dorsal pubescence is uniformly black; on each side of the basal segment there is a tuft of white hairs and on the remaining segments black hairs; the venter is black, covered with black scales and hairs.

The legs are black, covered with black scales and hairs; the pulvilli are dark.

The wings have a broad black or dark brown pattern, the apical half consisting of confluent blotches and clearer smoky areas; cell R_3 is divided by a crossvein; R_4 is branched, so that a triangular extra cell is formed; r-m is placed

before the middle of mc and R_{2+3} originates well before r-m and its loop is angular; M_{3+4} has a short appendix; the cubital cell is narrowly open.

The female differs from the male in the greater width of the frons at the head vertex and in the absence of silver scales on the apex of the abdomen.

Holotype male, Brisbane, January 23rd, 1926. F. H. Roberts. Length of the body, 5 mm.; of the wing, 5·5 mm. Allotype female, Brisbane, May 1st, 1926. J. Mann. Length of the body, 5·3 mm.; of the wings, 5·5 mm.

There are six paratypes in the author's collection (5 ♂, 1 ♀), all from Brisbane and collected about January, 1926. There are further specimens in the collections of J. Mann (Brisbane, Killara), the late Dr. E. W. Ferguson (Glenreagh, Dorrigo), Dr. I. M. Mackerras (Meringa, Gayndah).

In several collections, *confluensis* has been confused with *maculata*. There are three distinct characters for the separation of the two species; in *maculata* (1) the female, as well as the male, possesses a silvery-white apex on the abdomen, (2) R_4 is sometimes provided with an appendix, but never completely branched, (3) the discoidal portion of the third antennal segment is much broader than the second.

The holotype and allotype are in the Queensland Museum.

Anthrax ater, n. sp.

♂. The head is black; the occiput is black, somewhat shining, and covered with short, appressed, black hairs; the frons is black, slightly broader than the width of the ocellar tubercle at the vertex, and clothed with dense, erect, black hairs; the face is grey dusted, also covered with dense, black hairs; the cheeks are also grey dusted; the antennae are black, the third segment with a somewhat produced margin, so that it is slightly broader than the second; the style is not very distinctly marked; the proboscis is black; the eyes have a well developed hind indentation and a fairly distinct bisecting line.

The thorax is black, with anterior stiff brownish and black hairs; the dorsum is covered with black scales, and some golden or cuprous, appressed hairs, which are more conspicuous in front and above the wing insertions; the bristles are rather weak, black; the scutellum is black, covered with black scales, and thin appressed, golden hairs, and bears thin, weak, marginal bristles; the pleurae are grey dusted, with soft whitish or yellowish hairs; the squamae are black, with a very short fringe of whitish scales; the halteres are black.

The abdomen is black, covered almost entirely with black scales and hairs; on each side of the posterior border of the first segment there is a small line of white scales; the hairs on each side of this segment are yellowish, the remaining segments being covered laterally with sparse black hairs; the venter is black, covered mainly with black scales, but a few brown scales can be seen.

The legs are mainly black, clothed with black scales and hairs; the bristles are rather weak.

The wings are black, with a somewhat large, indented hyaline area below and towards the apex; the outline of this hyaline area is very irregular, and is almost divided by a broad black area, which projects down into it from the pattern of the wing and almost reaches the hind margin; there is a hyaline spot near the apex of cell R_5, and a second larger spot extending between mc and cell M_3; the veins are brownish and stand out from the rest of the wing; the cubital cell is closed a little before the wing margin; R_{2+3} has a rather small terminal loop.

Holotype male, Meringa, Q'land, November, 1926, Goldfinch. Length of body, 5 mm.; of wing, 4·5 mm.

There is a single paratype male, with the same locality and date, in the collection of Dr. I. M. Mackerras.

Both holotype and paratype are not in the best condition, and it is rather surprising to find that the apex of the abdomen is devoid of white scales, but this may be due to the condition of the specimens. The pattern of the wings is very distinctive and renders the species worthy of a description.

Anthrax concisa Macquart.

Anthrax concisa Macquart, *Dipt. Exot.*, suppl. 4, 1850, 111; Schiner, *Reise Novara*, Dipt., 1868, 125.—*Argyramoeba concisa*, Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 50.

♂. The head is black; the occiput is black, covered with short, appressed, black hairs and black and white scales, the white scales being more apparent near the hind indentations of the eyes; the ocellar tubercle is prominent, and is crowned with a few erect, black hairs; the face and frons are black, sometimes whitish along the inner eye margins, covered with dense, black hairs; the antennae are entirely black, the third segment usually not as broad at the base as the second; the proboscis is black, with brownish labella.

The thorax is black, covered dorsally with black scales, and black and golden hairs, the latter rather thin, appressed, and more or less confined to the front, and sides above the wing insertions; the hairs in front and on the sides are dense and mostly greyish; the bristles are black; the scutellum is black, covered with black scales, and with appressed, greyish hairs on its margin; the marginal bristles are black; the pleurae are grey dusted, with stiff black, and thin, greyish hairs; the squamae are light brown, with a short fringe of whitish hairs; the halteres are rather elongate, with brownish stems and yellowish knobs, which are black basally.

The abdomen has a band of soft, white hairs on the basal segment, but is otherwise covered with black scales and hairs; the apical segments are clothed with white scales; the hairs on each side of the basal segment are rather dense and white.

The legs are mainly brownish, though the femora appear blackish, and are covered with whitish scales and black hairs; in some specimens the legs are completely brown and are covered with black scales above and white scales below; the pulvilli are brown.

The wings have a broad black basal pattern, the outline of the black area extending from the hind border irregularly to r-m and thence along R_{4+5}, reaching the fore margin at about one-third of its length from the apex, so that the outline of the black portion appears angulated; the cubital cell may be closed at the wing border or narrowly open; cell R_2 does not possess an interradial vein; an appendix is sometimes present near the origin of R_{2+3}.

Length of body, 5-12 mm.; of wing, 6-11·5 mm.

Hab.—Q'land: Westwood, Brisbane, Chinchilla, Eidsvold; N.S. Wales: Sydney, Toronto, Wentworth Falls, Kosciusko.

Most of the specimens examined were in a bad condition, and I am unable to decide whether the females also have white scales on the apical segments of the abdomen.

ANTHRAX ANGULARIS Thomson.

Anthrax angularis Thomson, *Eugenies Resa*, Dipt., 1868, 482; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 52.

♂. The head is mainly blackish; the occiput is blackish, dusted with silver-grey and covered with small appressed black hairs; the frons is blackish, grey dusted along the inner eye margins, and clothed with dense erect black hairs; the face is grey dusted, covered with dense, white hairs, which extend along the inner eye margins to the middle of the frons; the antennae are entirely black, the third segment with a long and distinct style, and not as broad at the base as the second segment; the proboscis is black.

The thorax is blackish, with stiff, greyish hairs in front, and black scales and black and grey hairs on the dorsum, the latter appressed, and more dense in front of the scutellum and above the wing insertions; the bristles are black; the scutellum is blackish, covered with black scales and grey hairs, the grey hairs being more conspicuous at the base and along the margin; the bristles are well developed and black; the squamae are whitish with a fringe of white hairs; the halteres are black or brownish, with yellowish knobs; the pleurae are blackish, with white-grey hairs.

The abdomen is black, covered with black and white scales and hairs; thick white hairs cover the basal segment and are continued on each side as dense, white, hairy tufts; on each side of the second segment there is a small area or spot of white scales and hairs; the apex is also covered on each side with white scales and hairs; on the posterior border of the second segment there is a very narrow band of white scales, which does not quite reach the margins, and a further much smaller, median stripe of similar scales on the posterior border of the third segment; the remainder of the dorsum is clothed with black scales and hairs, the latter very dense on the sides of the second to the sixth segments; the venter is black, clothed with white scales and hairs.

The legs are blackish, the femora being covered with white scales.

The wings may be hyaline, with the base and fore margin brown, or the brown may be gradually extended, so that the basal half of the wing, except for most of the axillary lobe and portion of the cubital cell, is all brown; R_{2+3} possesses an appendix, which may be of various lengths, but never meets the vein R_1; R_4 has a distinct loop into cell R_4, from which there sometimes projects a small appendix; cell R_5 is always open, but the cubital cell may sometimes be closed at the wing border.

Length of body, 8-13 mm.; of wing, 9-14 mm.

The female, as far as I can determine with the material available, is similar.

Hab.—Q'land: Pt. Denison, Westwood, Brisbane, Chinchilla, Pt. Curtis; N.S. Wales: Sydney, Piper's Flats, Toronto; W. Australia: Wyndham. There are two specimens labelled South Australia only.

I have before me a series of sixteen specimens, in which a gradual extension of the brown area of the wing can be traced. Seven of the series have only the base and fore margin brown; three, the basal half almost completely brown; and the remaining six have the brown area showing a more or less gradual increase which eventually ends in the broad basal pattern.

ANTHRAX INCISA Macquart.

Anthrax incisa Macquart, *Dipt. Exot.*, suppl. 2, 1847, 52; White, *Proc. Roy. Soc. Tasm.*, 1916, 207; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 51.

♂. The head is black; the occiput is black, covered with appressed, black hairs and white scales, the latter more conspicuous near the hind indentations of the eyes; the face and frons are both blackish, clothed with dense, black hairs, and some whitish scales, which extend up the frons for one-half its length; the antennae are entirely black, the third segment not as broad at the base as the second; the proboscis is black; the eyes possess a well marked indentation of the hind borders and a distinct bisecting line.

The thorax is blackish, with stiff greyish hairs in front; on the sides the hairs are greyish, intermingled with which are numerous brown or golden hairs; the dorsum is covered with black scales and hairs, with some appressed golden pile in front; the bristles are black; the scutellum is black, covered with black scales, and with a little golden pile on the margin; the bristles are rather weak and black; the squamae are whitish with a fringe of whitish or brownish hairs; the halteres are light brown with whitish knobs.

The abdomen is black, with narrow brown posterior borders to the segments; the tomentum is mainly black, with brown hairs on the posterior borders of each segment, and a band of white hairs on the first; the apex is clothed with brown or white scales; on each side of the basal segment is a tuft of white or brownish hairs; the venter is brown, or black-brown, covered with brown scales and black hairs.

The legs are brown, with somewhat darker tibiae and tarsi, and covered with brown or white scales and brown hairs; the pulvilli are brown.

The wings have a broad black basal pattern, the outline of which is very irregular, and near the fore margin it descends as a dilation from cell R_1 into cell R_5; an appendix is present near the origin of R_{2+3}, but it never attains the vein R_1; the cubital cell is closed.

As far as an examination of the series will permit, I can distinguish no difference in the female.

Length of body, 4-10 mm.; of wing, 5-10·5 mm.

Hab.—Q'land: Eidsvold, Brisbane, Chinchilla; N.S. Wales: Sydney, Casino; S. Australia: Adelaide.

There are ten specimens of this species in the series under examination. They are mostly old specimens in a rather rubbed condition, and it has been hard to determine the extent of the white scales on the abdomen. In some of the series the pubescence is quite brown, even the scales on the apex of the abdomen, and I have been unable to decide whether this condition is due to age, though it probably is. The peculiar black pattern of the wings may be relied on, however, as a reliable character.

Anthrax incompta Walker.

Anthrax incompta Walker, *List Dipt. Brit. Mus.*, ii, 1849, 253.—*Argyramoeba incompta* Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 50.—*Anthrax semimacula* Walker, *List Dipt. Brit. Mus.*, ii, 1849, 254; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 51.

The head is black; the occiput is black, covered with appressed, black hairs and white scales; the face and frons are both black, clothed with dense, black hairs and white scales, which extend from the face half-way up the frons; the antennae are black, the basal portion of the third segment broader than the second; the apical pencil of hairs is very distinct; the proboscis is black; the eyes have a well marked indentation of the hind borders and a distinct bisecting line.

The thorax is blackish, clothed in front and on the sides with grey hairs, with which are mingled a few black hairs; the dorsum is clothed with grey appressed and erect black hairs; in front and on the sides there are some golden appressed hairs; the bristles are black; the scutellum is black-brown with black scales and some appressed grey pile on its margin; the bristles are well developed and black; the pleurae are somewhat blackish, with soft grey and stiff black hairs; the squamae are whitish with a fringe of white hairs; the halteres are brownish with whitish knobs.

The abdomen is black, with white scales on the posterior borders of the second, third and fourth segments, the scales forming bands or horizontal stripes of varying lengths; the penultimate and ultimate segments are covered on each side with a tuft of white scales and hairs; the remainder of the dorsum, except for the basal segment, which is clothed with dense white pile, is covered with black scales and hairs; the lateral pubescence consists of a dense white basal tuft, followed by dense black hairs, which extend to the white scales on the apical segments.

The legs are mainly blackish, with the middle and fore tibiae brownish; they are covered with black scales and hairs.

The wings have a broad black basal pattern, the outline of which is very irregular, and around the vein r-m it is dilated into an almost isolated spot; the brown portion includes some lighter areas or spots; the hyaline part contains two, three or four, generally four, brown spots, placed on various crossveins and bifurcations; the vein R_1 is greatly looped into cell R_1, and is usually provided with a short appendix near its origin with R_{4+5}; the cubital cell is narrowly open or closed at the wing border.

The female is similar, though apparently generally larger than the male.

Length of body, 4·5-10 mm.; of wing, 4-9·5 mm.

Hab.—Q'land: Cape York, Somerset, Brisbane, Chinchilla, Westwood; W. Australia: Perth, Geraldton. There are specimens in the Macleay Museum from New South Wales and South Australia. There are also two specimens in the Australian Museum, which were obtained from an exhibit which was sent from the Bismarck Archipelago.

I have recorded *semimacula* Walker as a synonym of *incompta*. There are two very old specimens in the series examined, in which the pubescence is mainly brown or golden, and the description of *semimacula* more or less agrees with these two specimens.

FOSSIL PLANTS FROM PLUTOVILLE, CAPE YORK PENINSULA.

By A. B. Walkom, D.Sc.

(Plates xiii-xiv, and two Text-figures.)

[Read 27th April, 1928.]

The plants described below were collected by Mr. C. C. Morton at Lower Camp, Plutoville, on the Cape York Peninsula. Preliminary determinations of the species were made by me for Mr. Morton about the end of 1923 for inclusion in his geological report on the area. The manuscript of this paper was completed towards the end of 1925, the intention being for it to form a continuation of the series of papers on the Mesozoic floras of Queensland published by the Queensland Geological Survey. Cessation, for the time being, of publication of palaeontological papers by the Geological Survey has been responsible for the delay in the appearance of the paper.

The following remarks on the age of the beds were written for Mr. Morton's account of the geology of the district (*Queensland Government Mining Journal*, March and April, 1924):—

"Of some nine or ten species from Plutoville not one appears to be present in the Walloon Flora as we know it, whereas the two species of which I feel reasonably certain, viz., *Nathorstia* (probably *N. Willcoxi*) and *Microphyllopteris gleichenioides* have been found only in Cretaceous rocks in Queensland, the former in the Styx Series, the latter in the Burrum Series and also at Croydon. Furthermore, the known species of *Nathorstia* are so far confined to the Cretaceous. In view of these facts I feel satisfied to say that the Plutoville fossil plants indicate a Cretaceous age for the rocks in which they occur".

The species now described include: ? *Lycopodites* sp. A., ? *Lycopodites* sp. B., *Ruffordia Mortoni*, n. sp., *Hausmannia Wilkinsi*, n. sp., *Nathorstia Willcoxi* Walkom, *Microphyllopteris gleichenioides* (O. and M.), *Nilssonia plutovillensis*, n. sp., ? *Nilssonia* sp., *Pagiophyllum* sp. A., *Brachyphyllum crassum* (?) Tenison-Woods, *Elatocladus* cf. *conferta* (O. and M.).

The only difference calling for remark, between this list and the preliminary determinations supplied in 1923, is the absence from the revised list of *Pterophyllum*. Closer examination has led me to conclude that the specimens which I originally thought to represent two or even three species of *Pterophyllum* should all be united under a single species of *Nilssonia* for which I have proposed the name *N. plutovillensis*.

Comparison of the species in this small collection with species from other Mesozoic floras leaves little doubt that the palaeobotanical evidence points strongly to a Cretaceous age for the beds in which the plants are found. The four species of ferns (*Ruffordia Mortoni*, *Hausmannia Wilkinsi*, *Nathorstia Willcoxi* and *Microphyllopteris gleichenioides*) all indicate a Cretaceous age, the two first-named having closest affinities with species occurring in Cretaceous rocks in other

regions. *Nathorstia Willcoxi* is known only from the Styx Series (Cretaceous) in Queensland, and species of *Nathorstia* in other parts of the world are only known from Cretaceous rocks. *Microphyllopteris gleichenioides* also is known from other parts of Queensland, having been recorded from Cretaceous rocks in the vicinity of Croydon, as well as from the Burrum Series, and doubtfully, from the Styx Series. The species of *Nilssonia* are not regarded as giving reliable indication of age. The coniferous fragments do not give definite indication, both *Brachyphyllum crassum* and *Elatocladus conferta* occurring in Jurassic as well as Cretaceous rocks.

I would like to express my appreciation of the courtesy of Mr. W. N. Edwards of the Geological Department of the British Museum in connection with a collection of plants, from the same district as those described here, forwarded to the British Museum by Capt. G. H. Wilkins. Mr. Edwards enquired whether I had in hand any material from this area and, on learning that I had already prepared the preliminary account for Mr. Morton's report, he very kindly volunteered not to proceed with a description of the collection under his care. It is worthy of record that his determination of the age of the collection as Lower Cretaceous corresponded with mine. As there appear to be some specimens in the British Museum collection different from those in the Queensland Geological Survey collection I give here the list of Mr. Edwards' provisional determinations of the former.

* *Microphyllopteris* (*Gleichenites*) *gleichenioides* (O. and M.).
Microphyllopteris (*Gleichenites*) cf. *acutus* Walkom.
* *Hausmannia* cf. *Pelletieri* Sew.
* *Ruffordia acrodentata* (Font.).
Sphenopteris cf. *fittoni* Seward.
? *Sphenopteris* sp. (cf. *Coniopteris*).
* *Nilssonia schaumburgensis* (Dunk.).
Pterophyllum cf. *Lyellianum* Dunk.
* *Elatocladus* sp.
* *Brachyphyllum* sp.
* ? *Sphenolepidium* sp.
? *Pityophyllum* sp.

Those marked with an asterisk appear to be the equivalents of some of the species described below.

? Lycopodiales.

? Lycopodites sp. A. Text-fig. 1.

A single specimen shows portion of a shoot with two rows of laterally disposed leaves in one plane. The leaves are about 2 mm. long and 1 mm. wide; they have an acute, upturned apex, both lower and upper margins curving upwards away from the stem. There is a very pronounced medial depression in the leaf.

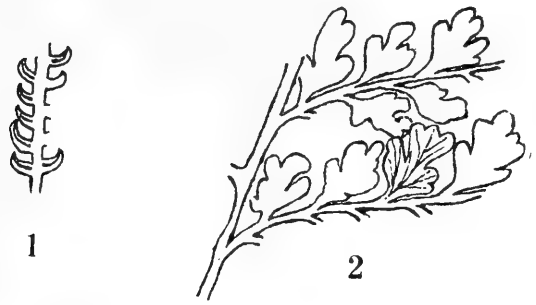
The habit of this fragment suggests a comparison with *Lycopodites falcatus* L. and H. (Seward, 1910, p. 83, fig. 137) but the specimen is not sufficiently complete for accurate determination. As no species allied to this genus has been recorded from Mesozoic rocks in Queensland it is of interest as indicating the probable existence of members of this group in these rocks.

It is not very different from portions of the fragments described from the Jurassic of Victoria as *L. victoriae* (Seward, 1904, p. 161, Pl. viii, figs. 2-4).

? LYCOPODITES sp. B. Plate xiii, fig. 1.

Portion of a branching shoot with short, narrow, acutely pointed leaves, apparently arranged in two rows. Leaves 3 mm. long, 1·5 mm. broad at base. Venation indeterminate.

There is a considerable degree of doubt as to whether these specimens are correctly placed in *Lycopodites*, but I figure one and suggest the possibility. Associated with these and the species described above, also referred to *Lycopodites*,



Text-fig. 1.—*Lycopodites* sp. A. (× 2).
Text-fig. 2.—*Ruffordia mortoni*, n. sp. (× 2).

are numerous delicate fragments which are regarded as coniferous, as well as small twigs which are below referred to *Pagiophyllum*. It is difficult to deal satisfactorily with them in view of the absence of specimens for comparison and of the comparatively few examples of Mesozoic Lycopodiales that have been figured. The remote locality from which the specimens were obtained makes it rather improbable that any detailed collecting from the fossil-bearing beds will be carried out there.

Filicales.

RUFFORDIA MORTONI, n. sp. Plate xiii, fig. 2; Text-fig. 2.

Frond tripinnate; pinnae elongate, alternate; pinnules delicate, broadly oval, divided more or less deeply into segments, contracted and decurrent at the base; ultimate segments broad, obtuse, sometimes with finely dentate margin; venation sphenopteroid.

This delicate fern is the first of its kind that I have seen from Australian Mesozoic rocks. The only one at all similar is *Coniopteris hymenophylloides* from the Jurassic of Victoria (Seward, 1904) and the Clarence Series of New South Wales (Walkom, 1919), but from this, the present specimens are quite distinct. These Queensland specimens are apparently very close to *Ruffordia Göpperti* (Dunk.) var. *latifolia* Seward (1894, p. 85, Pl. vi, fig. 1) which has been included by Berry (1911, p. 230, Pl. xxiii) as a synonym of *Ruffordia acrodentata* (Fontaine). It appears to me that on Plate xxiii of Berry's work (1911), figures 3 and 4 which are named *R. Goepperti* should be *R. acrodentata* and figures 5 and 6, named *R. acrodentata*, should be *R. Goepperti*. Some of the examples under discussion here are very close to Berry's figures 3 and 4.

All the specimens in our collection are sterile examples and in the absence of any fertile examples I have thought it wiser to give the specimens a distinct specific name, rather than to associate them with European examples, of which

the fertile pinnae are known. The European *R. Göpperti* var. *latifolia* is of Wealden age, and the American *R. acrodentata* occurs in the Patuxent and Patapsco Formations, of Cretaceous age.

HAUSMANNIA WILKINSI, n. sp. Plate xiii, figs. 3, 4.

Lamina broadly wedge-shaped, deeply divided into two or three narrow segments, which themselves are further divided, but not so deeply; a series of primary, dichotomously branching, radiating veins, one branch going into each ultimate segment; the spaces between the primary veins occupied by a fairly regular fine network.

In the specimens available the larger segments are about 1·5 cm. wide at their widest part and about 2 cm. long. There is a certain amount of variation which may indicate the presence of more than one species, but as the number of specimens is small all are for the present referred to a single species.

Previously the only reference to *Hausmannia* in Queensland is the doubtful one, of a single specimen from the Esk Series (Walkom, 1917*a*), which in no way resembled those now under discussion.

These specimens show a fairly close resemblance to *H. Pelletieri* described by Seward (1913, p. 89, Pl. xiv) from the Wealden Beds of Sussex, England, but the leaf appears to be much more dissected and the network of secondary veins is coarser than in that species. *H. dichotoma*, a Wealden and Jurassic species, has the lamina very deeply dissected but is a considerably larger form than ours.

Recent representatives of the family Dipteridinae to which *Hausmannia* belongs are found in New Guinea, and the discovery of this late Mesozoic species in a region not far distant is perhaps worthy of remark.

NATHORSTIA WILLCOXI Walkom. Plate xiv, figs. 1, 2.

The examples of this species are more complete in some respects than those previously described from the Styx Series. The frond has a length of more than 8 cm. and a width of 1·0 to 1·3 cm., and is obtusely rounded at the apex, the nature of the base still remaining unknown. The veins are strong, at right angles to the midrib, 6 to 11 per cm. of lamina, and only occasionally branching, while on very rare occasions two veins join. In one example a fine network of veins can be seen between the prominent secondary veins (Pl. xiv, fig. 1). All the examples from Plutoville are sterile leaves, but it is one of the commonest species in the collection.

MICROPHYLLOPTERIS GLEICHENIOIDES (O. and M.). Plate xiv, fig. 3.

This species has previously been recorded from the Burrum Series in the type district (Walkom, 1919*a*, p. 26) and also from the Marine Cretaceous rocks in the vicinity of Croydon. A doubtful record has also been made from the Cretaceous rocks of the Styx Series (Walkom, 1919*a*, p. 56). A similar, though larger, species, *M. pectinata*, has been described by Arber (1917) from Jurassic and Neocomian rocks in New Zealand.

Cycadophyta.

NILSSONIA PLUTOVILLENSIS, n. sp. Plate xiii, figs. 5-7.

Frond up to about 3·5 cm. wide; rachis strong, up to 2 mm. wide, and frequently showing longitudinal folds or striations; lamina divided into segments of variable width, ranging from 2 mm. to 6 mm., attached to upper surfaces of

rachis but apparently does not cover the whole surface, leaving a central portion visible from above; veins fine, parallel, occasionally branching, 8-14 in 5 mm.

This species appears to be common. It differs from other Queensland species, and some difficulty has been experienced in comparing it with other species. The wide variation in some of the described Jurassic species would make it possible, perhaps to include these examples, e.g. with *N. compta* or *N. schaumburgensis.*

In *N. schaumburgensis,* however, the lamina completely covers the upper surface of the rachis and in this respect our specimens would appear to be different from that species. There is some degree of similarity between *N. plutovillensis* and the specimens of *N. compta* described by Arber (1917, p. 51) from Lower Jurassic rocks in New Zealand.

It is almost certain that the rocks at Plutoville, in consideration of the contained fossil flora, are of Lower Cretaceous age, and for that reason it is considered unwise to refer these specimens to any species of Jurassic age in other parts of the world. It appears at the present time that great care must be exercised in using species of *Nilssonia* and *Pterophyllum* for the purpose of fixing more exactly the age of Mesozoic rocks in which these genera occur.

? Nilssonia sp. Plate xiv, fig. 4.

Portion of a frond with long, narrow, curved pinnae 3·5-4 cm. long, acutely pointed, 0·5 cm. broad at base. The venation is very imperfectly preserved but there appear to be about 5 veins per pinna.

The single specimen here described recalls in some respects, particularly as regards the curvature of the pinnae, the figure of *N. orientalis* given by Seward (1911, Pl. x, fig. 46) from the Jurassic flora of Sutherland. It is, however, poorly preserved and no further details can be given until more material is available.

Coniferophyta.

Pagiophyllum, sp. A.

The collection contains some small twigs of a conifer which may be referred to *Pagiophyllum.* The leaves are short, broad, thick and keeled, and make a wide angle with the axis. They are 1½-2 mm. long by 1-1½ mm. broad.

These specimens can be matched closely with fragments described by T. G. Halle from the Mesozoic flora of Grahamland (1913, p. 79) and correspond closely with his Plate 9, figs. 5*a* and 6.

Brachyphyllum crassum (?) Tenison-Woods. Plate xiii, fig. 8.

A number of branched coniferous stems with broad, fleshy, spirally arranged leaves are referred to *Brachyphyllum,* and doubtfully to the common Australian species *crassum.*

There are numerous examples in the collection from Plutoville, and they show no character by which they can be separated from examples of *Brachyphyllum* already described from Jurassic and Lower Cretaceous rocks in Queensland.

Similar specimens have been described from the Jurassic of Grahamland by Halle (1913, p. 79, especially Pl. 9, f. 15, 16).

Elatocladus cf. *conferta* (O. and M.). Plate xiii, figs. 9, 10.

Numerous fragments of branches with narrow leaves may be referred to *Elatocladus.* They are smaller than and different in general appearance from

E. planus which occurs in the Walloon Series (Jurassic) and Burrum Series (Lower Cretaceous) in Queensland.

The leaves are only 6 mm. in length and about 0·5 mm. in width and have a distinct midrib.

It is compared here with *E. conferta*, with which it may be conspecific. *E. conferta* has been figured from the Jurassic of Grahamland (Halle, 1913) and of New Zealand (Arber, 1917). It may also be compared with *Taxites* sp. figured from the Uitenhage Series of South Africa by Seward (1903, Pl. 6), but this is somewhat larger than our species.

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EXPLANATION OF PLATES XIII–XIV.

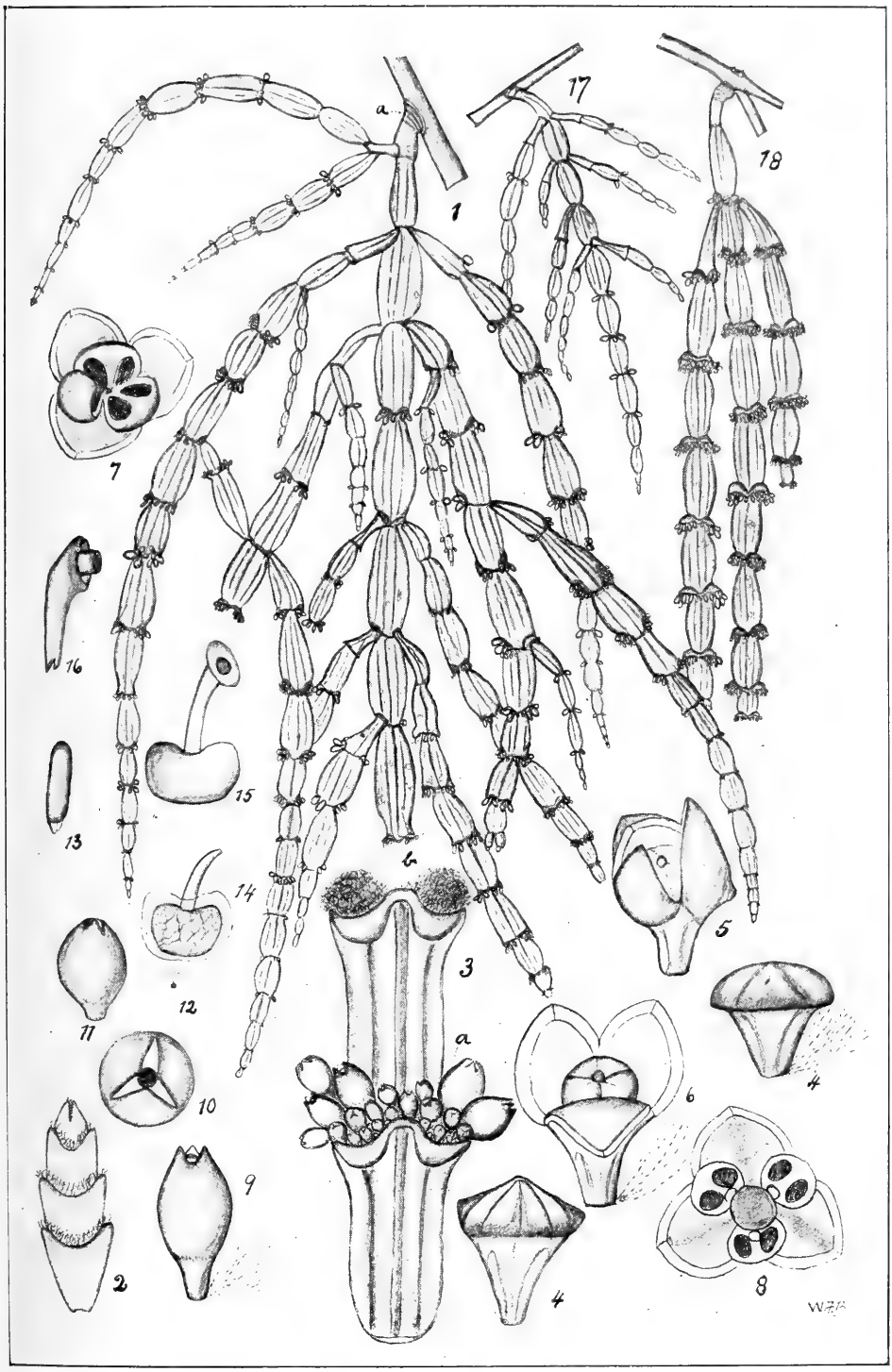
(Figures are natural size except where marked.)

Plate xiii.

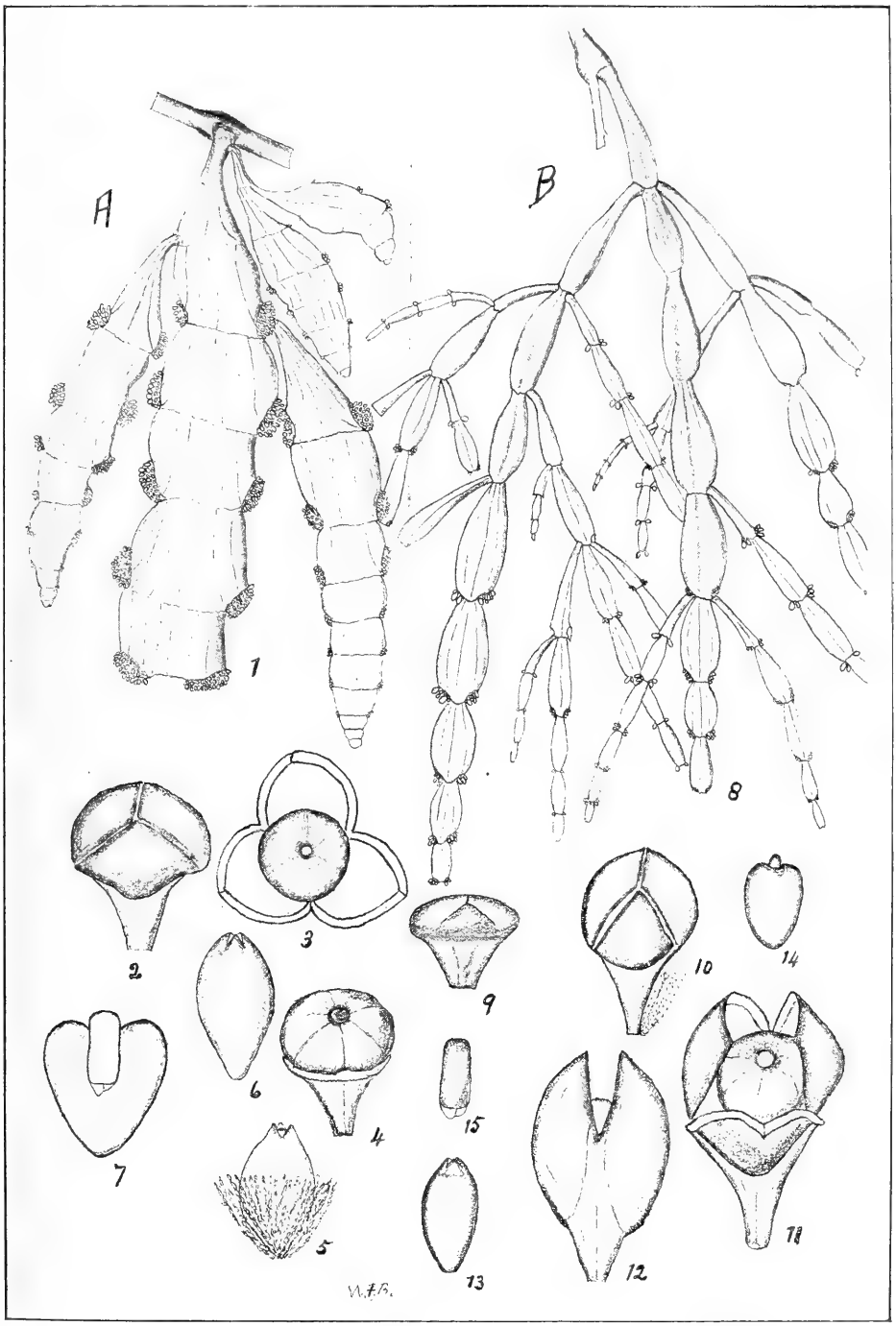
1. *Lycopodites* sp. B, slightly enlarged.
2. *Ruffordia Mortoni*, n. sp.
3, 4. *Hausmannia Wilkinsi*, n. sp. Fig. 4, slightly reduced.
5, 6, 7. *Nilssonia plutovillensis*, n. sp. Fig. 1, slightly reduced.
8. *Brachyphyllum crassum* (?), Tenison-Woods. × ¾. Shows some partly defoliated stem.
9, 10. *Elatocladus* cf. *conferta* (O. and M.), slightly reduced.

Plate xiv.

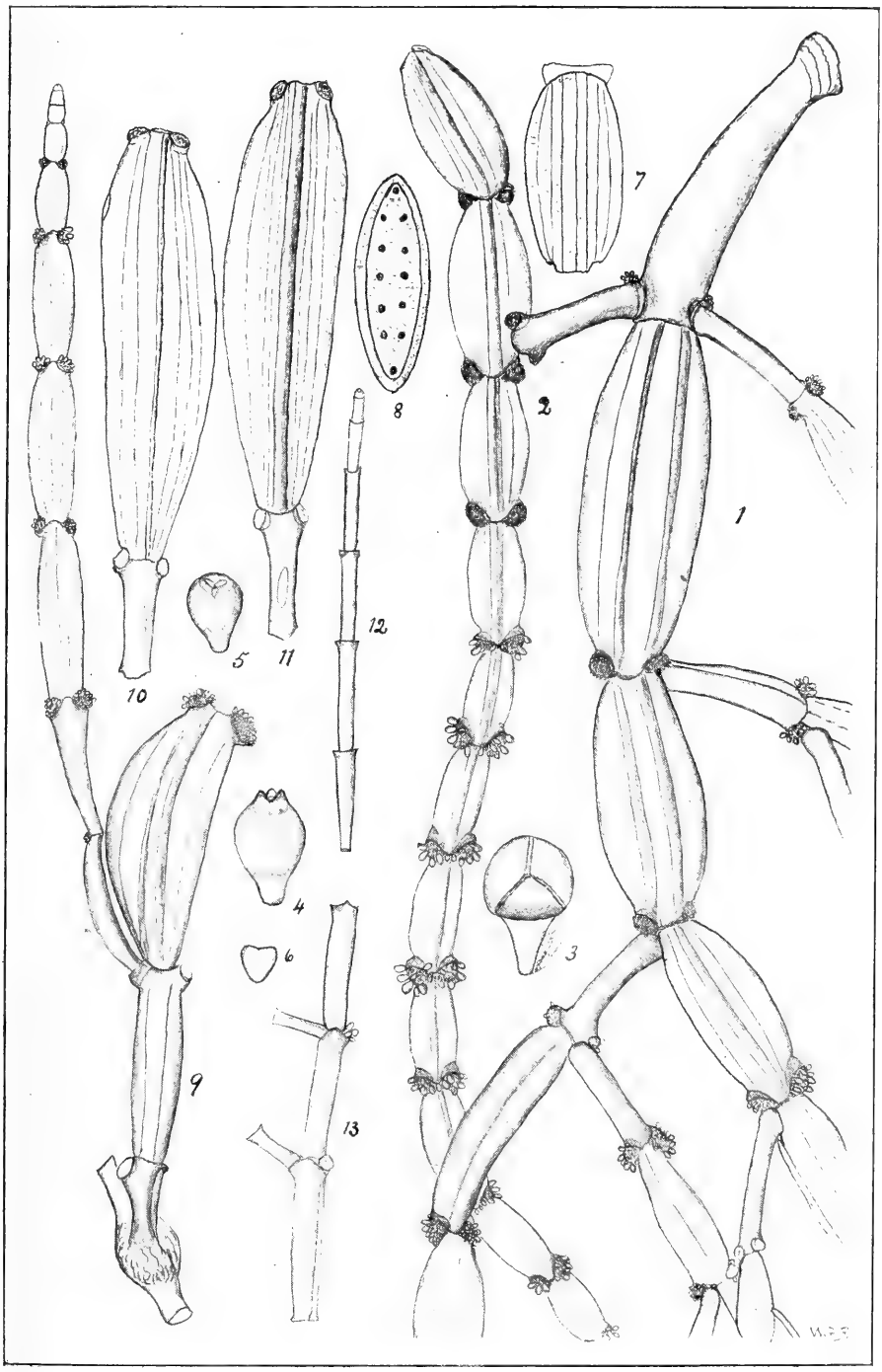
1, 2. *Nathorstia Willcoxi* Walkom. Fig. 1, × $^{11}/_{7}$; Fig. 2, × $^{5}/_{6}$. Figure 1 shows the fine network between the secondary veins.
3. *Microphyllopteris gleichenioides* (O. and M.), × $^{6}/_{5}$.
4. *Nilssonia* sp., × $^{9}/_{8}$.



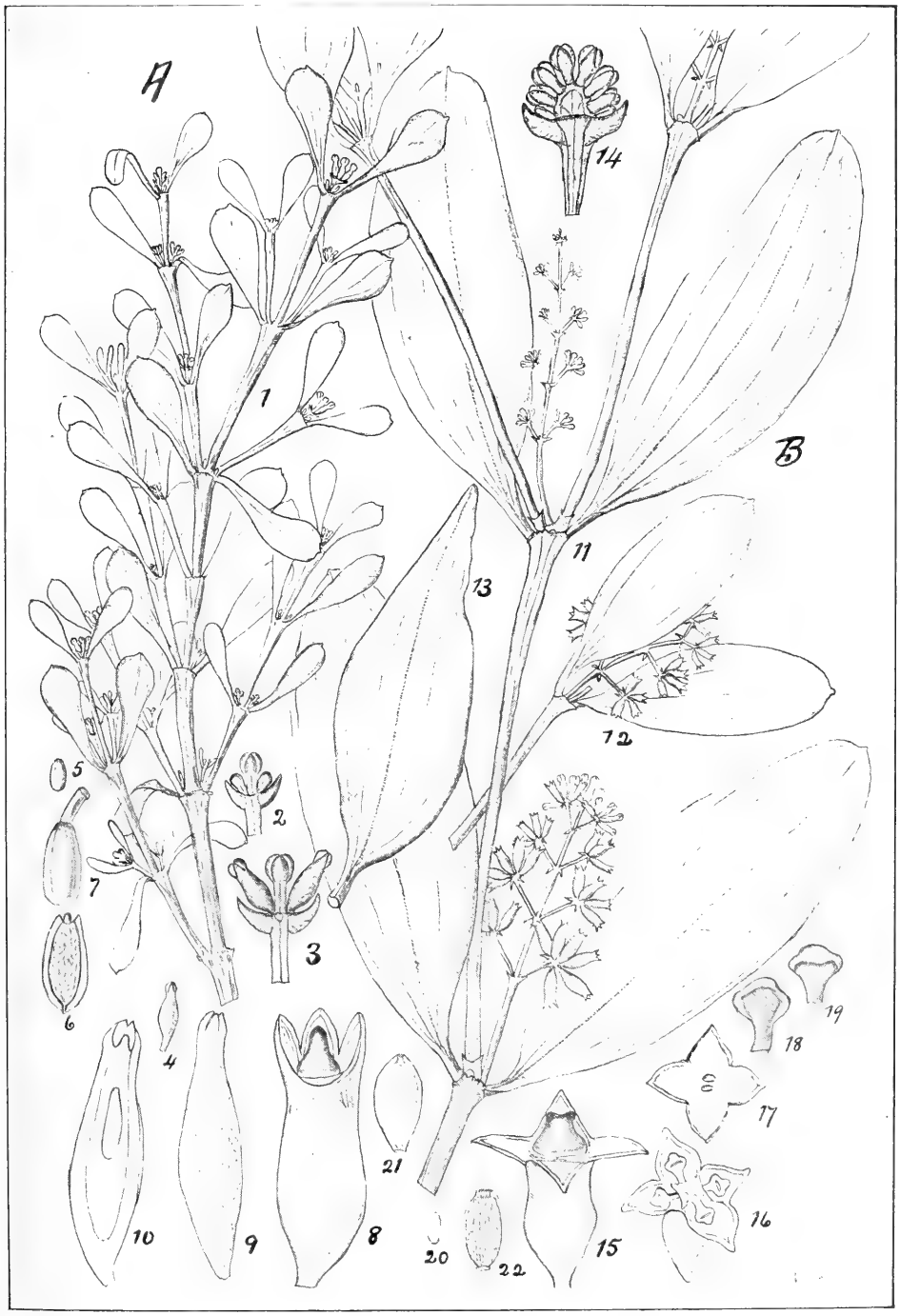
Korthalsella articulata (Benth.) Blakely.



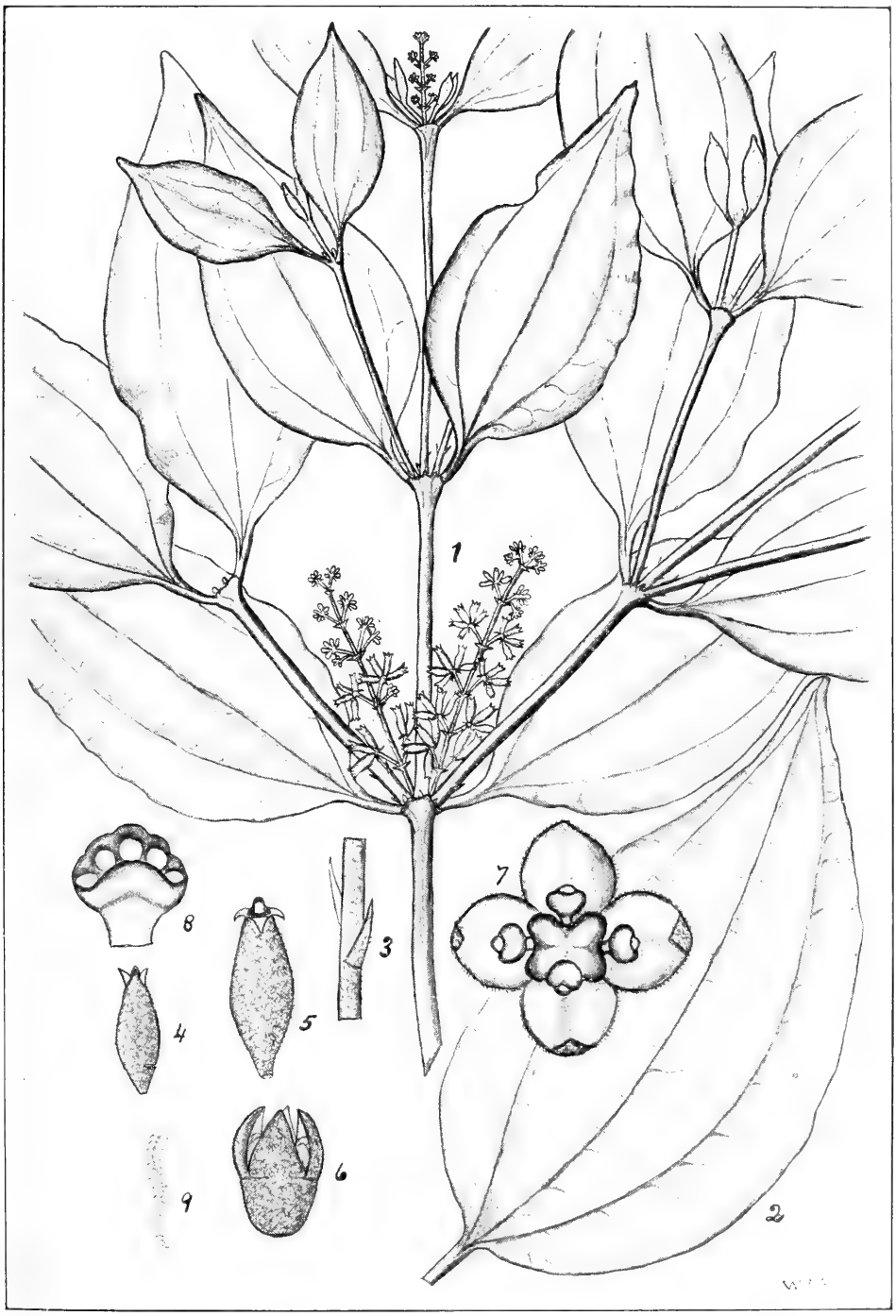
1-7 (A). *Korthalsella australis* (Bail.) Blakely. 8-15 (B). *K. Howensis* (Van Tiegh.) Engl.



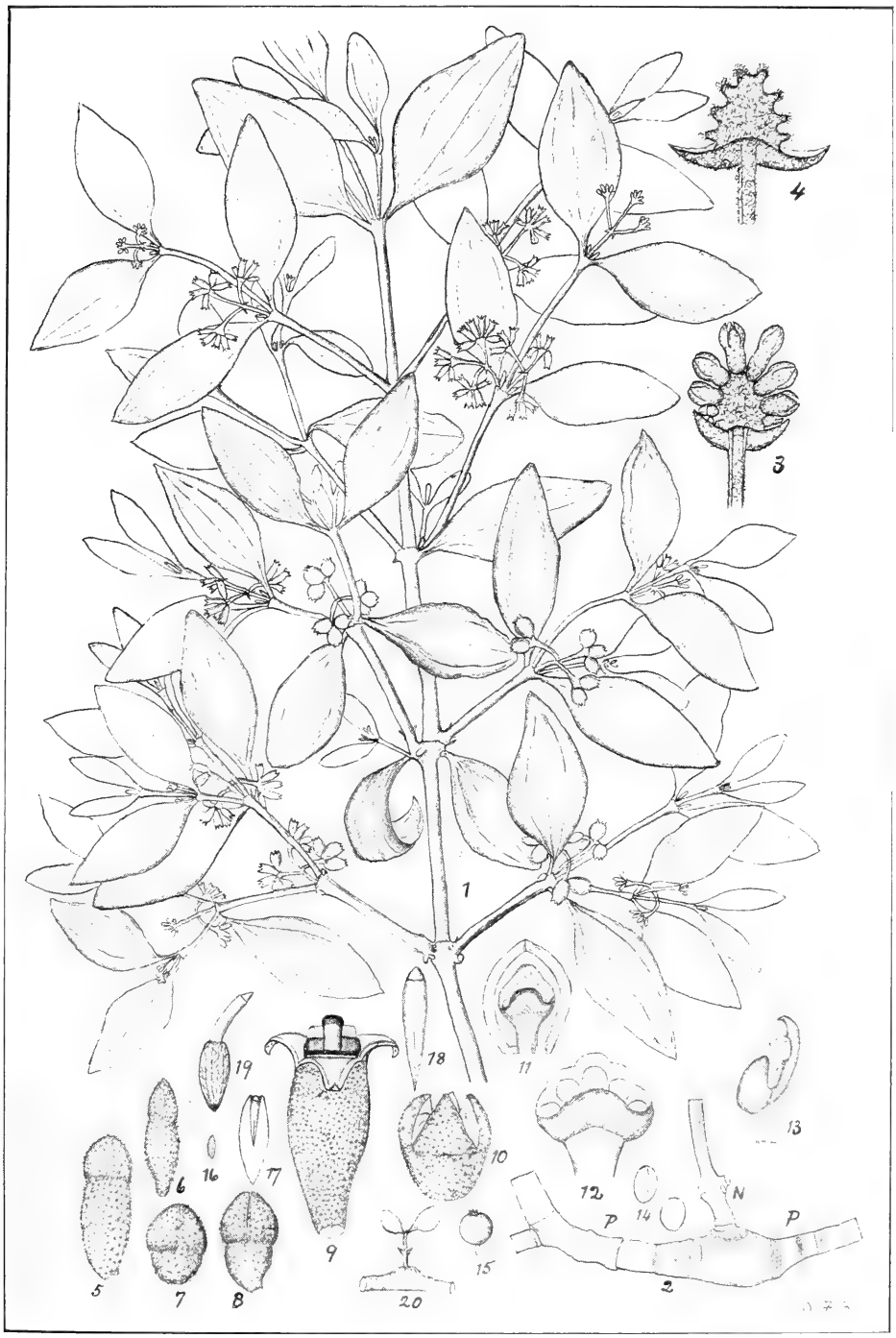
1-11. *Korthalsella opuntioides* (Bauer) Blakely. 12-13 ? *K. bigibba* (Van Tiegh.) Engler.



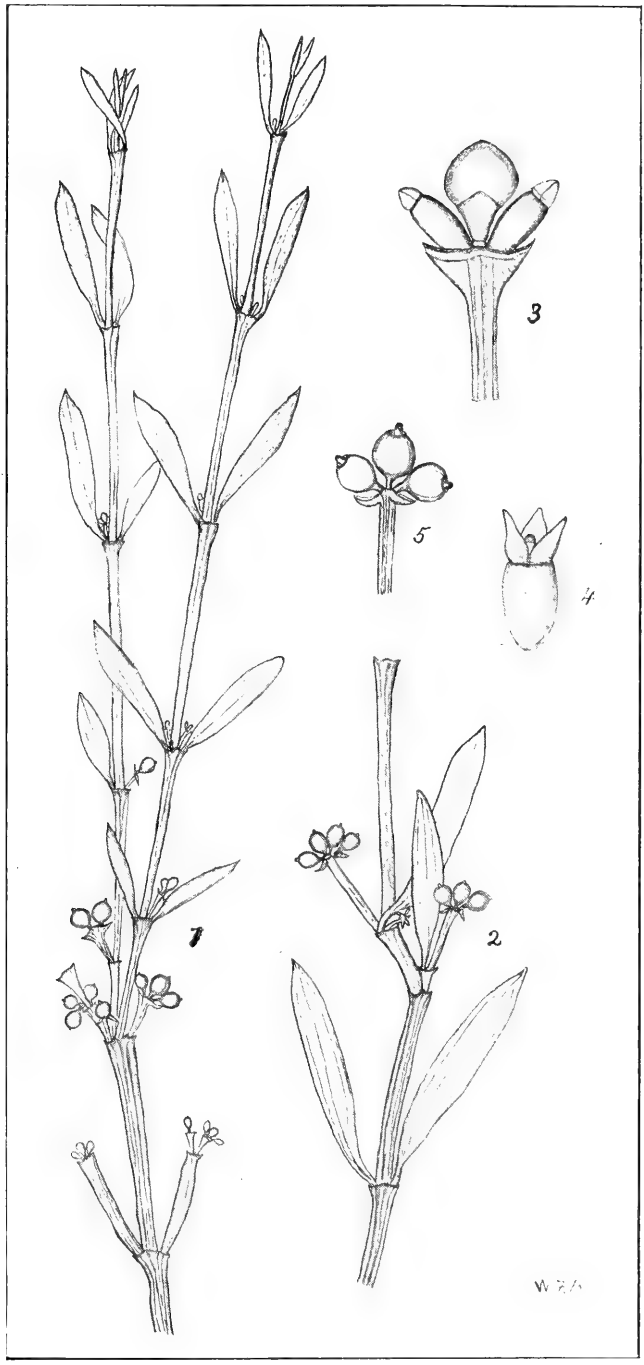
1-10 (A). *Notothixos incanus* Oliv. 11-22 (B). *N. cornifolius* Oliv.



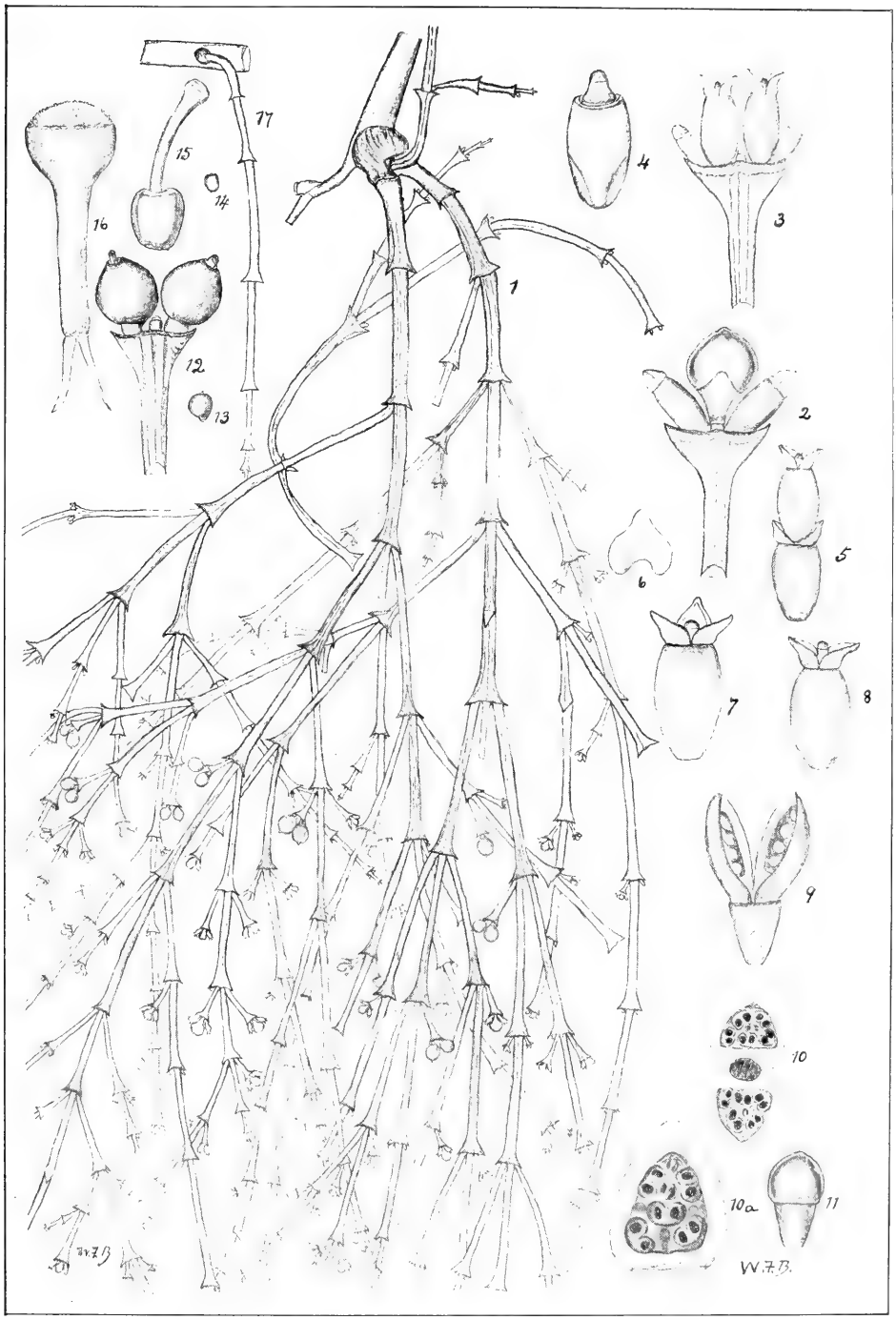
Notothixos leiophyllus K. Schu.



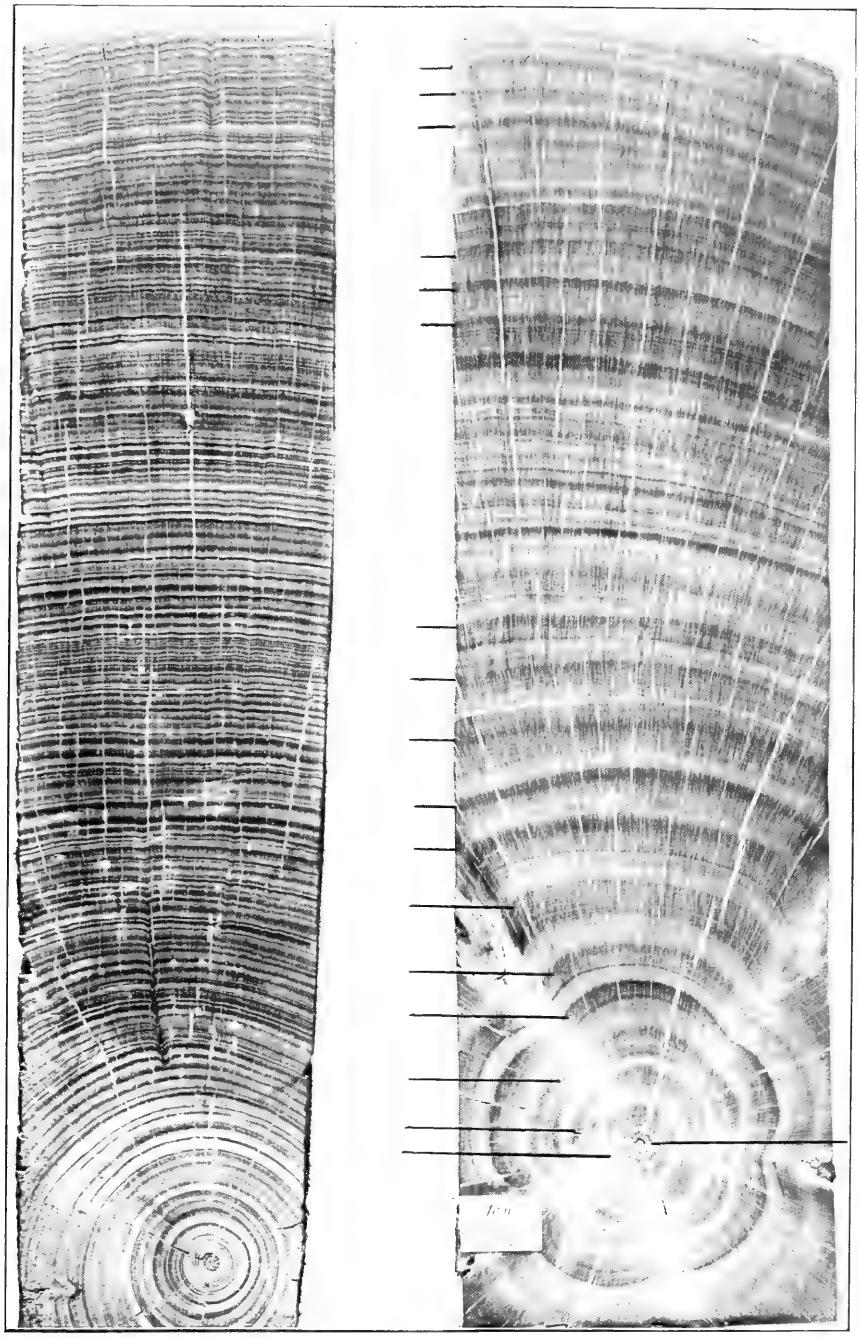
Notothixos subaureus Oliv.



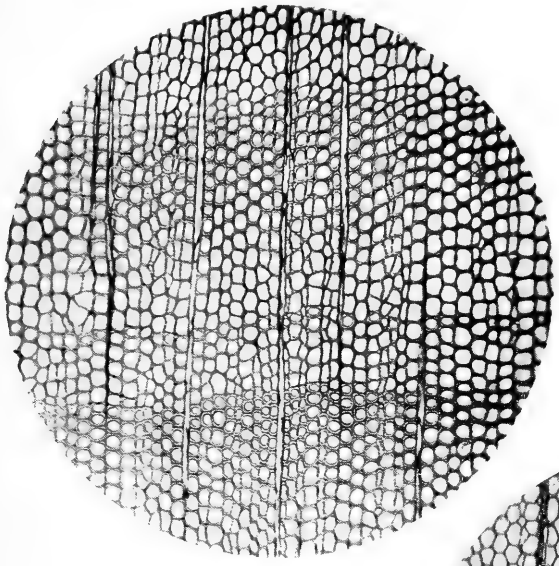
Viscum Whitei, n. sp.



Viscum Bancrofti, n. sp.



Araucaria Cunninghamii—smoothed surface of sections.



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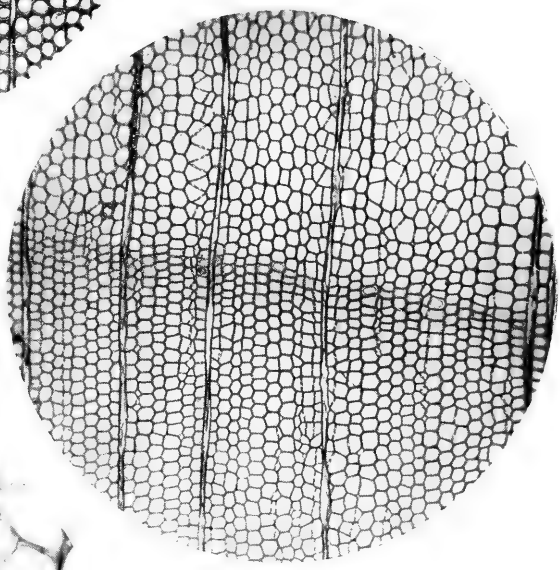

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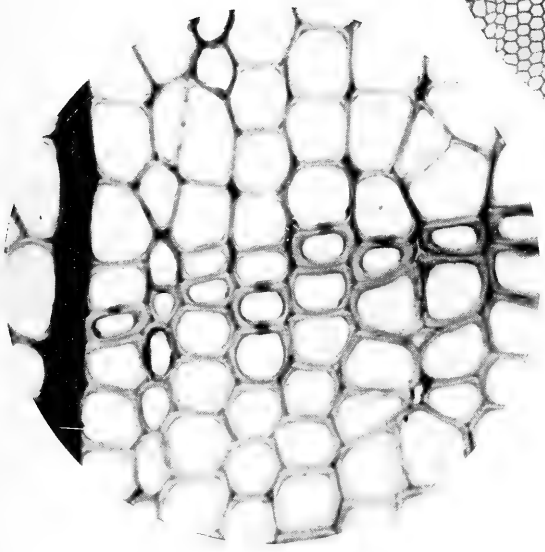
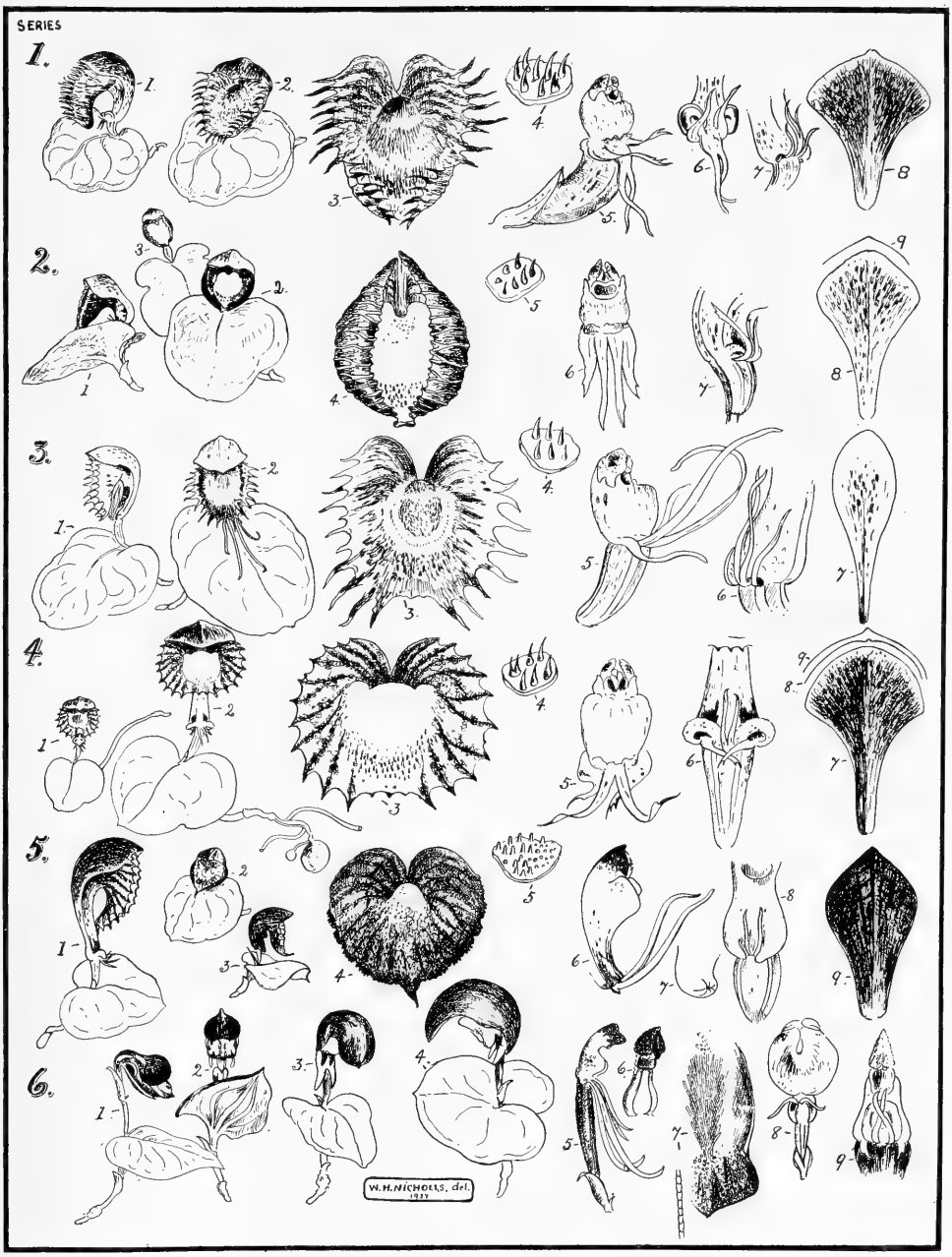


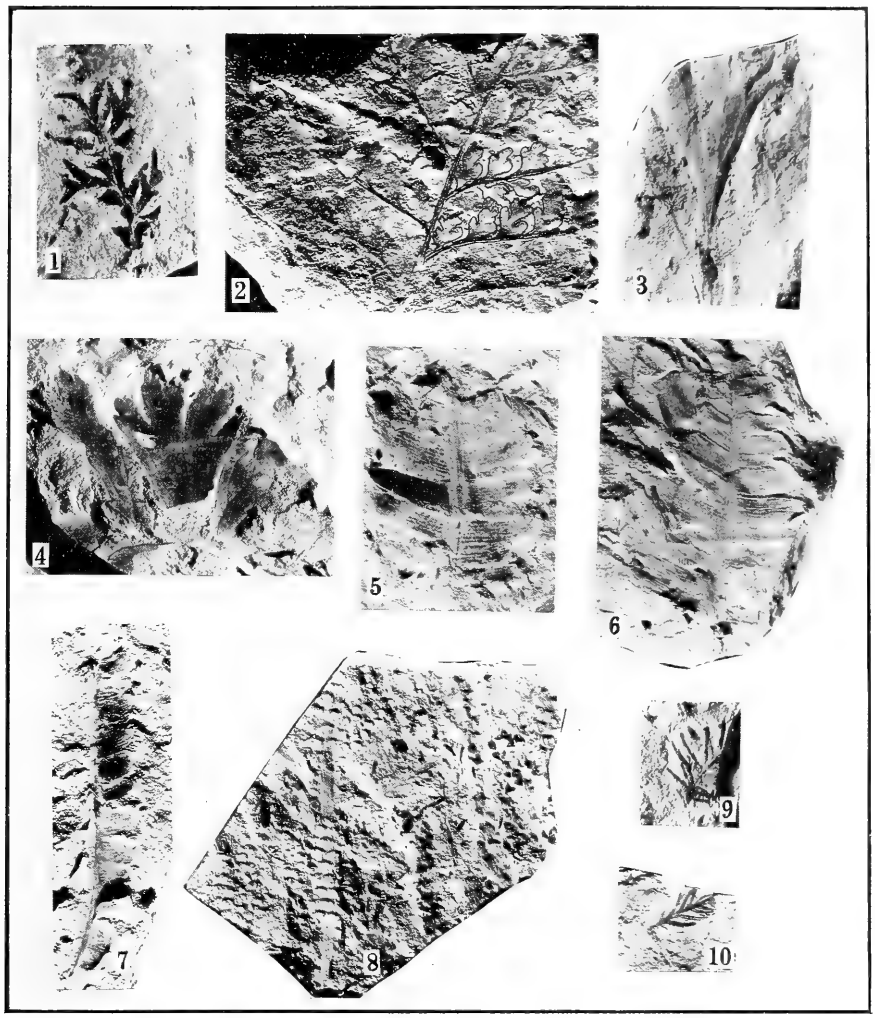
3

Transverse sections of (1) *Araucaria Cunninghamii* (× 40), (2) *A. Bidwilli* (× 40), and (3) *Agathis robusta* (× 170).

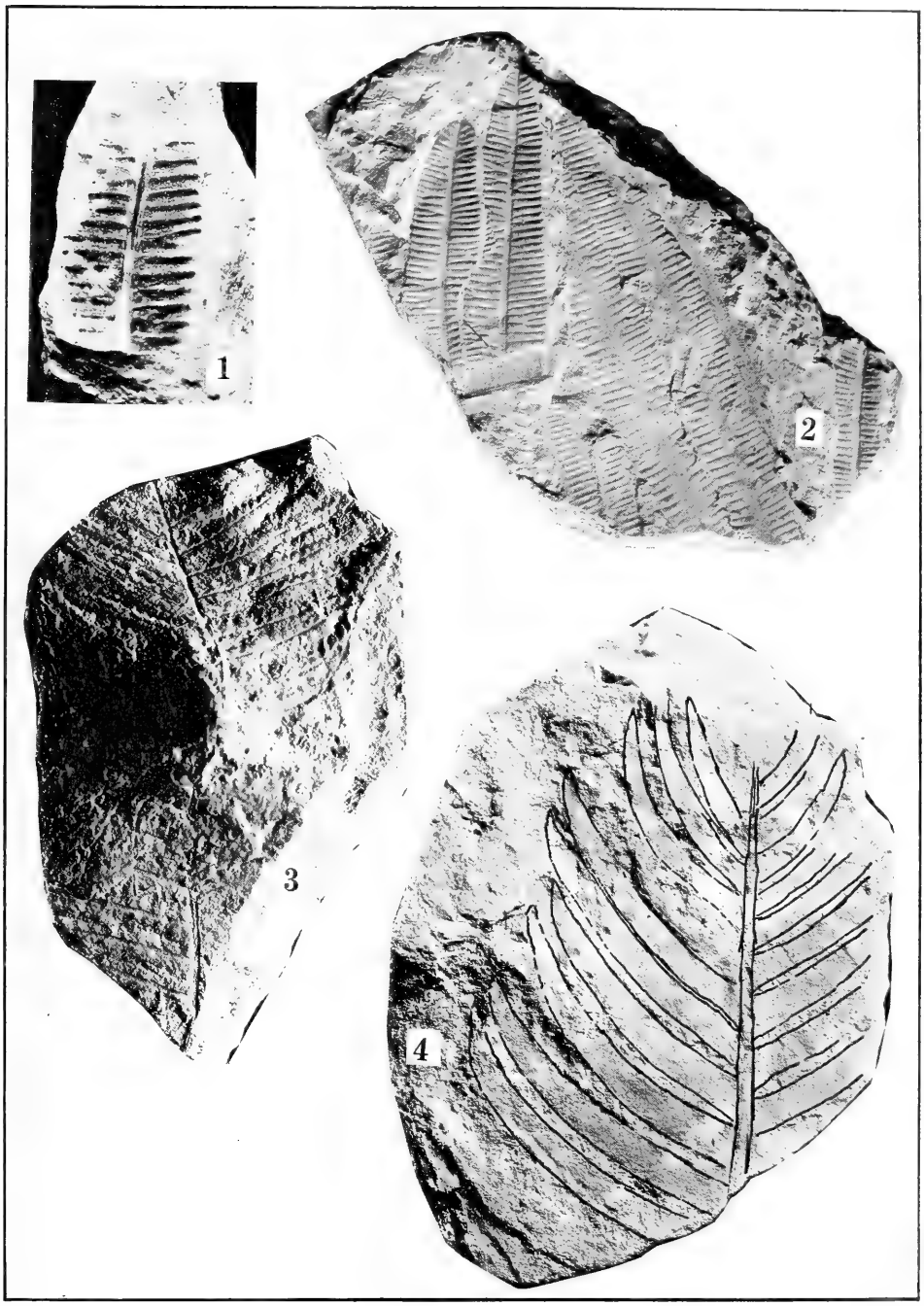


Species of *Corysanthes*.

1. *C. fimbriata*. 2. *C. diemenica*. 3. *C. pruinosa*. 4. *C. dilatata*.
5. *C. dilatata* and *C. undulata*. 6. *C. unguiculata* and *C. bicalcarata*.



Fossil plants from Plutoville, Cape York Peninsula.



Fossil plants from Plutoville, Cape York Peninsula.

THE GEOLOGY OF THE SOUTH COAST OF NEW SOUTH WALES.

Part i. The Palaeozoic Geology of the Moruya District.

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(Plates xv-xviii; four Text-figures.)

[Read 30th May, 1928.]

(1) Introduction and Previous Records.
(2) General Geology.
(3) The Sedimentary Series.
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(i) Occurrence and Field Relations; (ii) Structures; (iii) Petrography of the Plutonic Rocks; (iv) Field Occurrence and Petrography of the Dykes; (v) Petrogenesis; (vi) Age of the Intrusion.
(5) The Metamorphic Series.
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(1) Introduction and Previous Records.

The area under consideration is situated on the south coast of New South Wales, two hundred miles south of Sydney. The town of Moruya, situated five miles from the mouth of the Moruya or Deua River, is the centre of a large dairy-farming district, and has recently been brought under public notice by the reopening of "granite" quarries by the firm of Dorman, Long and Company, Limited, in order to supply stone for the building of the Sydney Harbour Bridge.

No detailed geological work on this district has hitherto been attempted, although one finds references to the Moruya district in several reports of the Departments of Mines and Agriculture of this State. An analysis of Moruya granite was published by Professor A. Liversidge in his "Minerals of New South Wales", and is quoted in a paper by W. Anderson (1892) on "The General Geology of the South Coast", where a very brief account of the geology of the Moruya District is recorded.

Further reference is made by Dr. H. I. Jensen in a paper on "The Soils of New South Wales", and short reports of an economic nature have been made by L. F. Harper (1910), and T. L. Willan, B.Sc. (1923).

(2) General Geology.

The general geological structure of the district might be described briefly as that of a folded and faulted series of early Palaeozoic sediments, which has been intruded by a series of plutonic rocks, ranging from gabbro to biotite-granite. Several systems of igneous dykes intersect the whole region.

Conglomerates, which are supposed to be of Devonian age, form a capping over the steeply inclined older sediments in a few places, and Tertiary sediments and basalts cover considerable areas within a few miles of the present coast-line.

The Post-Tertiary history includes the evolution of the present physiography, with the accumulation of quantities of alluvium, recent sands, and shell deposits along the rivers, coastal lagoons and low-lying coastal areas.

* This work was commenced when the writer held the position of Demonstrator in Geology at the University of Sydney.

It is proposed to give in this paper an account of the Palaeozoic Geology of the Moruya District, and at a later date to deal with the Tertiary and Post-Tertiary History of the South Coast.

(3) The Sedimentary Series.

The older sedimentary rocks of the district have been subjected to a certain amount of regional metamorphism, but still show evidence that they were originally fine-grained sediments, which were deposited under fairly stillwater conditions. They are represented now by thin-bedded quartzites and silky, purple or greenish-grey slates, some of which possess well-developed cleavage. On the road to Araluen, eleven miles from Moruya, the slates and interbedded quartzites dip to the west at 43° and contain distinct ripple marks; the ridges of the ripples are about two and a half inches apart and run east and west, thus indicating a shallow water origin for the sediments.

The only traces of organic remains yet known in this series occur in sandy purple slates on the northern bank of the Deua River, about 22 miles by road from Moruya. These fossils are not well preserved, but, in the opinion of Mr. Dun, Government Palaeontologist, they are certainly organic, and are probably the carapaces of crustaceans.

For convenience these old, altered sediments will be referred to as "slates", or the "slate series", it being understood that the term includes all the slates, phyllites and thin-bedded quartzites of Pre-Devonian age.

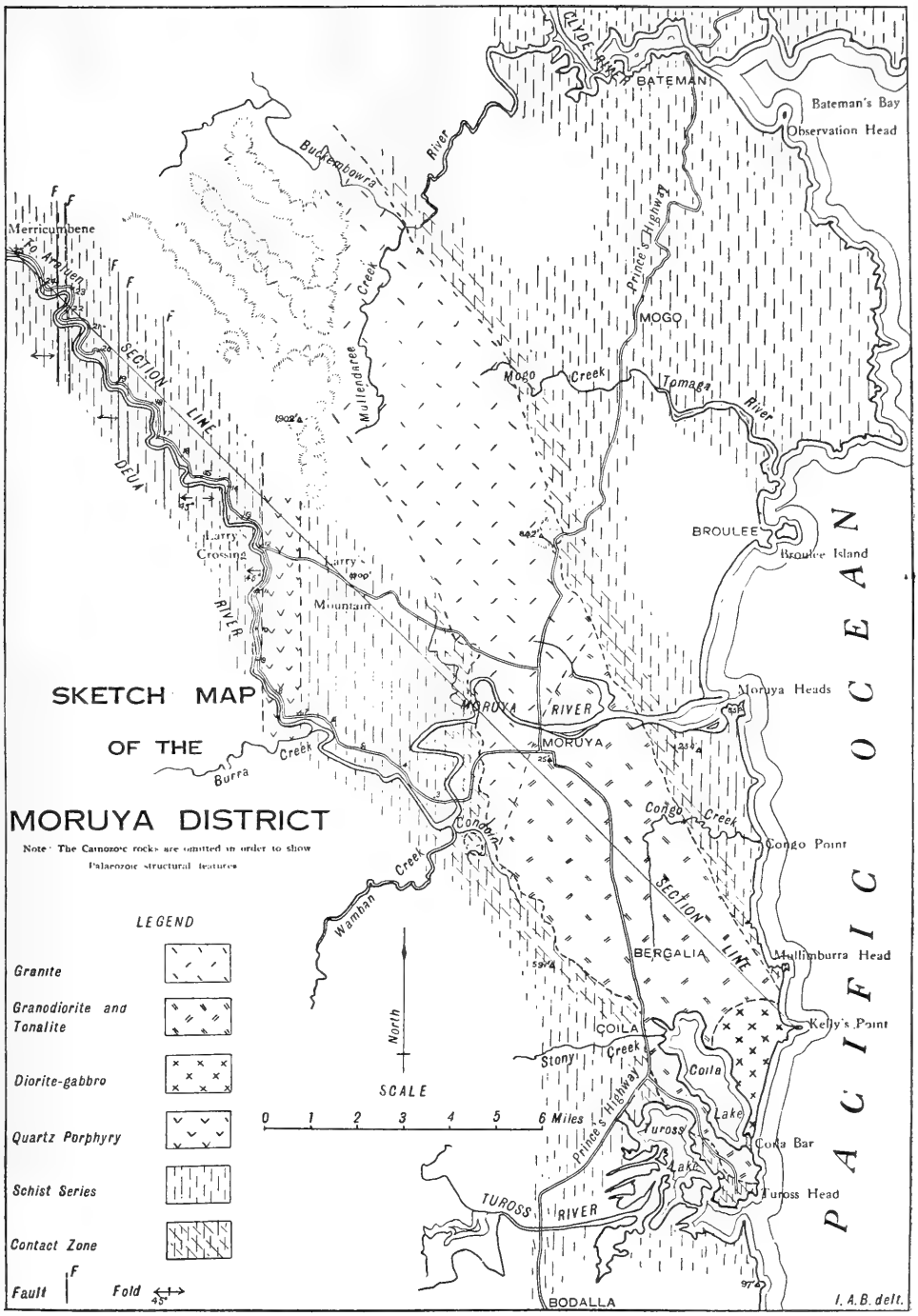
These slates form part of a series, which extends from the head of the Clyde River in a southerly direction for about ninety miles to the Brogo-Tathra district, and from the coast in a westerly direction for about thirty miles to the Main Divide. At intervals they are interrupted by intrusions of igneous rocks consisting of granites, monzonites and more basic types, which outcrop at Moruya, Bodalla, Mount Dromedary, Cobargo, Brogo and Bega along the coast, and several other places further inland. The slates are also partly covered by later Palaeozoic and Cainozoic sediments and basalts.

The geological age of the series has not yet been proved, as up to the present there is no record of any fossils having been found in them. Specimens of *Favosites* were discovered by W. Anderson (1892) in limestone at Bendithera, nearly thirty miles west of Moruya, at the head of the Deua River, and an Upper Silurian age is assigned to these beds. Unfortunately, the relation of the limestone to the slates to the east is not known at the present time.

In 1851 the Rev. W. B. Clarke examined the granites and slates in the neighbourhood of Araluen and lower down the Deua River, and later examined the Clyde Valley and Yalwal Districts. He evidently considered the slates to be Silurian in age, apparently basing his opinion on the lithological character of the rocks, and their similarity to Silurian rocks on the western side of the Main Divide.

Later writers have accepted this provisional classification, and one finds in a number of reports on mining in the southern goldfields, references to the slate series as of possibly Silurian age.

For the purpose of soil classification, Dr. H. I. Jensen (1910) has divided the series into two parts, (*a*) the Nelligen Schists, extending from near Termeil to the south of Bodalla, and (*b*) the Narira Schists, extending from seven miles south of Bodalla to Brogo, but this division is somewhat misleading from a geological standpoint.


SKETCH MAP
OF THE
MORUYA DISTRICT
Note: The Cainozoic rocks are omitted in order to show Palaeozoic structural features
LEGEND
Granite
Granodiorite and Tonalite
Diorite-gabbro
Quartz Porphyry
Schist Series
Contact Zone
Fault
Fold
North
SCALE
0 1 2 3 4 5 6 Miles
PACIFIC OCEAN
BATEMAN
Bateman's Bay
Observation Head
CLYDE RIVER
Buckembowra River
Mullendaree Creek
Prince's Highway
MOGO
Mogo Creek
Tomaga River
Merricumbene
To Araluen
SECTION LINE
DEUA RIVER
Larry Crossing
Larry's Mountain
BROULEE
Broulee Island
Moruya Heads
MORUYA RIVER
MORUYA
Burra Creek
Congo Creek
Congo Point
Wamban Creek
Condon
SECTION LINE
BERGALIA
Mullimburra Head
Kelly's Point
COILA
Stony Creek
Coila Lake
Prince's Highway
Tuross Lake
Coila Bar
Tuross Head
TUROSS RIVER
BODALLA
I. A. B. delt.

Text-fig. 1.

Within a radius of approximately thirty miles of Moruya, the slates consist of a folded series, which have a constant direction of strike, running within a few degrees of north and south. Small exposures of the slates, such as occur in road cuttings along the Prince's Highway, show only beds which are apparently vertical; larger exposures, however, all clearly show that the series has been subjected to meridional folding, which has been very intense over the eastern portion, gradually diminishing in intensity to the west. This is illustrated by the cliff-sections east of the town of Bateman, on Bateman's Bay, the sea-cliffs near the mouth of the Tomaga River, and the section revealed by the erosion of the Deua River between Moruya and Araluen.

Faulting has accompanied or closely followed the folding along parallel axes. This fact, together with the complete absence of a fossil-horizon*, and the more or less uniform nature of the sediments, makes it impossible to estimate the thickness of the series outcropping over such a large area.

A belt of quartz-porphyry, more than one mile in width, occurs about seven miles west of Moruya and trends in a northerly direction. It appears to be intrusive along one of the fault-planes. The porphyry is inclined to be tuffaceous towards both eastern and western boundaries, containing small angular fragments of felsitic rocks: towards the west it has the appearance of being interbedded with vertical bands of slate. A narrow band of similar porphyry occurs in a fault-zone through hardened sandstone and reddish-purple slates, between 21 and 22 miles along the road from Moruya to Araluen. There seems little doubt that the porphyry is really intrusive into the slate series.

As previously stated, the folding is most intense in the rocks which lie to the east. In the neighbourhood of Observation Point, east of Bateman, the rocks consist of crushed conglomerates and contorted, banded quartzites and slates, which are faulted in a meridional direction. These extend to the headland known as the "Hanging Rock", about a mile from Bateman. Half a mile of shell-banks, raised only a few feet above sea-level, separates this outcrop from the typical greenish-grey slates of Bateman, which appear to belong to a series younger than that of the crushed conglomerates to the east. No actual junction between the two series has been seen by the writer, but observations on the rocks between Bodalla and Narooma suggest a similar division into two series, without any marked angular unconformity, the older lying to the east of the younger.

The occurrence of small veins of turquoise in the vicinity of Bodalla and Eurobodalla as recorded by Curran (1896, p. 252) has been taken as an indication that these rocks are Ordovician, but as yet there is no definite evidence as to whether the slates are Ordovician or Silurian.

(4) The Igneous Series.

(i) *Occurrence and Field Relations.*

An examination of the accompanying geological map of the Moruya District (Plate xv) reveals the fact that the plutonic rocks outcrop over a belt some three and a half miles in width, extending from the neighbourhood of the coast north of Tuross Head in a north-north-westerly direction through Moruya and out to the west of Mogo. The writer was unable to complete the mapping in this direction on account of the mountainous and inaccessible nature of the country, but has some reason for believing that the mass is connected with the mountain granites east of Araluen.

* The discovery by the writer, subsequent to the completion of this paper, of *Spirifer disjuncta* in quartzites at Coondella, about 12 miles west of Moruya, proves the presence of Devonian rocks, and there is a possibility that the quartzite series immediately west of the quartz porphyry may be of this age.

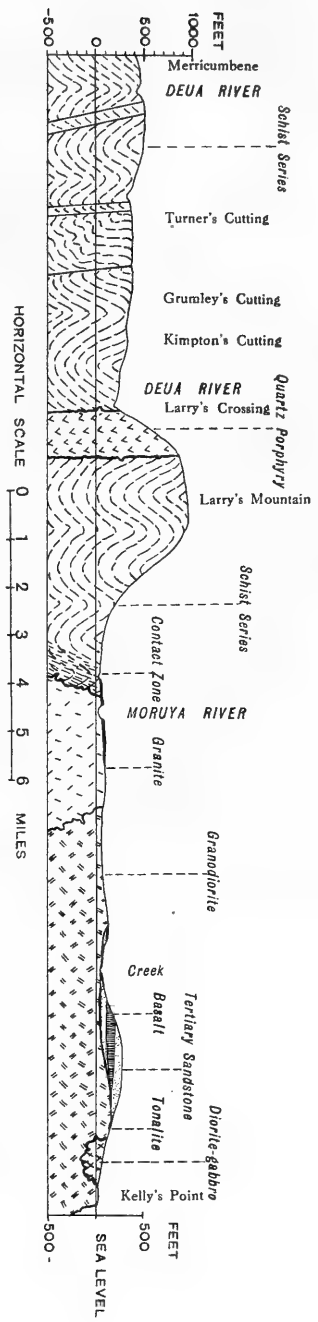
The general directions of the eastern and western boundaries of this mass are similar, consideration being given to the fact that it is in part covered by newer formations, including Tertiary sediments and basalts between Coila and Congo Point, and more recent alluvium over the flats of the Moruya River and Congo Creek. This feature may be more clearly seen in the modified map given in Text-figure 1, where the Cainozoic formations are omitted.

The occurrence of granitic rock has quite a marked effect on the topography, producing gently undulating country rarely rising to an altitude of 200 feet on the coastal portion of the area, whilst the adjacent steeply-inclined slates and schists produce rough, hilly country showing very much greater relief. This feature is well-illustrated near the Beashel trigonometrical station, about a mile west of Bergalia, where the contact slate rises to an altitude of 600 feet above sea-level, within less than half a mile of the low-lying granite area, quite close to sea-level. The slate ridges west of Moruya rise to over 2,000 feet.

In like manner the differences in the resultant soil have produced a variation in the vegetation, which is quite striking even to the casual observer. The slates weather to rather poor, siliceous soils, although they support a number of valuable timbers. *Eucalyptus maculata* (spotted gum) is characteristic, and sometimes attains a great height; a magnificent specimen is growing near the 6-mile peg south of Bodalla. *Eucalyptus corymbosa* (bloodwood), *E. pilularis* (blackbutt), *E. eugenioides* (stringybark), and occasionally *E. siderophloia* (ironbark) flourish on the slate soil, with patches of *Acacia* (?) *penninervis* (myall) and *Backhousia* (myrtle) in sheltered positions.

The burrawangs, *Macrozamia*, are very abundant on the slate soil and are practically absent from the granitic soil, thus forming a good index of the character of the underlying rock.

E. (?) *hemiphloia* (box) and *Angophora* (?) *subvelutina* (apple) occur on the granitic soils, with some *E. siderophloia* (ironbark) and *E. eugenioides* (stringybark).



Text-fig. 2.—Generalized geological section from Merricumbene to Kelly's Point, Moruya district.

From an agricultural viewpoint the slates are practically useless, as the soil is too shallow, except where it has been collected along river-flats, whereas the soil derived from the igneous rocks is suitable for dairy-farming. For this reason the chief centres of settlement along this part of the coast are on outcrops of igneous rocks, which are separated by large tracts of slate country, inhabited only by timber-getters and occasional miners.

The igneous rocks in the Moruya district consist of a series ranging from gabbro, through tonalite (quartz-diorite) and granodiorite to biotite-granite, with associated dykes of porphyry and aplite. The intermediate plutonic rocks, the tonalite and granodiorite, outcrop over the greater portion of the area mapped in detail (Plate xv), while the gabbros occur to the south-east, and the acid granites occur to the north-west of the intermediate series.

It will be shown (p. 184) that the igneous series as a whole is intrusive into the slates, but it is overlain by Tertiary sediments and basalts between Coila and Congo Head, and by alluvium along the river flats, as shown on the map.

The individual members of the series, the gabbro, tonalite-granodiorite, and biotite-granite, are fairly uniform in composition, and do not grade into one another.

The field relations between the gabbros and tonalite may be studied along the sea coast at Kelly's Point, and at the head to the north, known locally as the Clear Hill Point, about 10 miles south-east of Moruya, where there are excellent exposures of the contact. Kelly's Point is an exposed headland, which runs out to sea for some distance at right angles to the general trend of the coastline, and is of intense interest, not only on account of the relations of the plutonic rocks, but also because of the occurrence of a series of peculiar dyke-rocks which will be described later. A geological sketch-map of the most easterly portion of the Point is given in Text-figure 3. The tonalite contains numerous dark-coloured inclusions of igneous rocks, similar to the "basic segregations" occurring in the granodiorite. At its junction with the diorite-gabbro, the tonalite has sent off numerous sharply-defined little apophyses into the invaded rock, leaving no doubt as to its later intrusion.

The tonalite and granodiorite appear to grade into one another, and outcrop over part of the Tuross Peninsula, and from Bergalia to the township of Moruya.

The granodiorite and the biotite-granite are lithologically distinct: the granite forms an isolated outcrop in the neighbourhood of Condoin Creek and occurs also in the main belt to the north and north-west of Moruya. The field relations between the granodiorite and granite are obscured by alluvium and cultivation patches, but as deposits of gold and silver-bearing arsenical-pyrites are associated only with the biotite-granites, it is considered that the granite is most probably of later formation than the granodiorite.

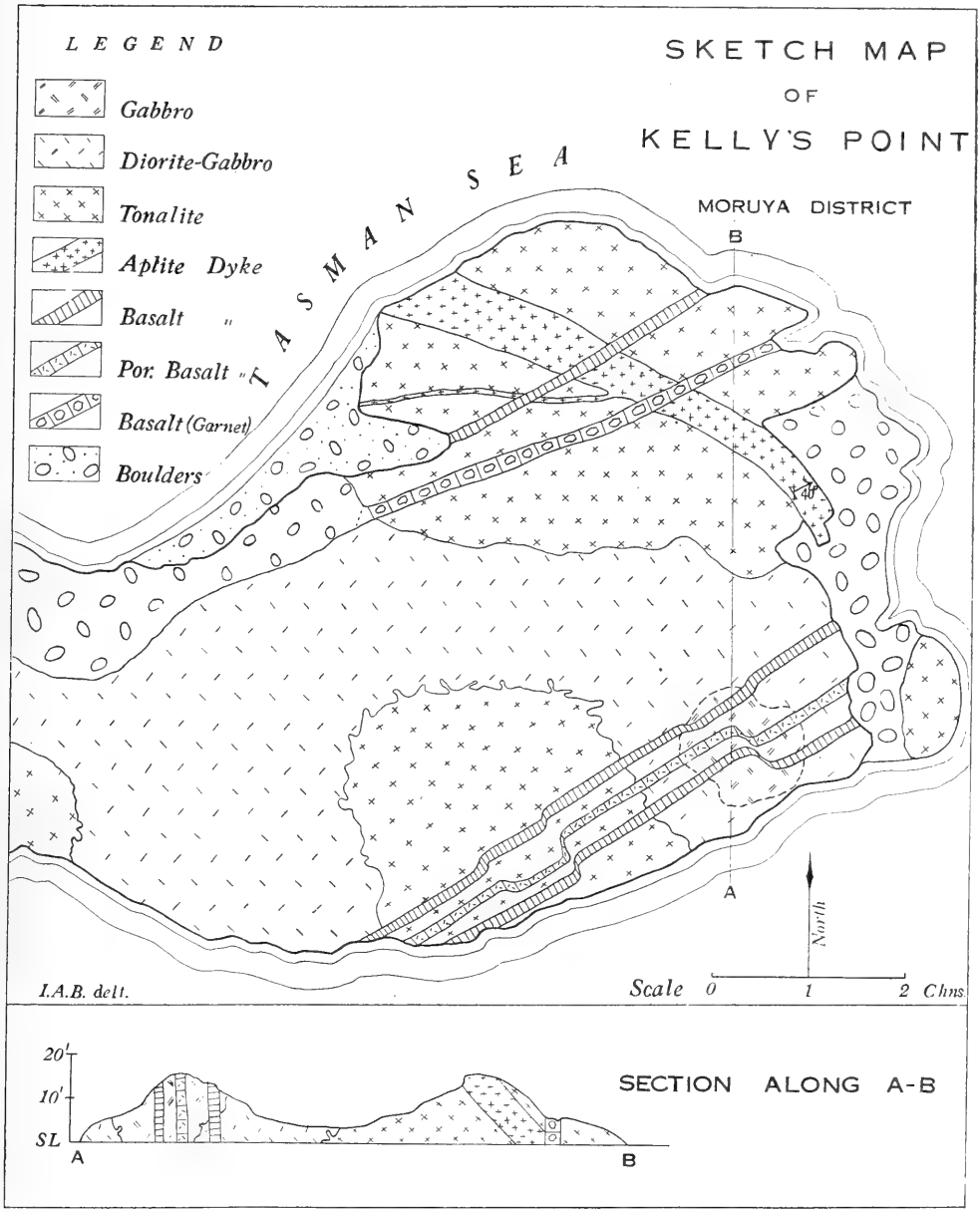
Several systems of dykes intersect the whole region, and are described in detail below. In the intermediate plutonic series there occur numerous dark inclusions, some of which are fragments of the slate series and others are igneous rocks, whose origin is probably co-magmatic with that of the granodiorite.

(ii) *Structures in the Plutonic Rocks.*

There are certain structures in the igneous mass itself which show evidence of crustal strains operating about the time of its intrusion. These include (*a*) jointing, and (*b*) "rift and grain" structure.

(*a*) *Jointing.*—At Pollwambra Mountain, five miles north of Moruya, vertical jointing is very distinct in a direction E. 10° N. At the quarries at present being

worked by Dorman, Long and Co. vertical joints occur in two principal directions, E. 10° N. and N. 20° W., whilst jointing in a third direction N. 50° E. is not so well developed and is parallel to a dyke of a basaltic nature, which for a time marked



Text-fig. 3.

the eastern boundary of the smaller quarry opened up to the west of the old main quarry.

Aplitic veins less than one inch in thickness occur parallel to minor joints dipping at 45° to the north-east in Dorman, Long's quarry, and at 50° to the south-west in Louttit's quarry, on the southern side of the River.

Locally, a kind of sheet structure is developed in the main quarry owing to the presence of a system of joints which are more or less horizontal, with a downward sagging in the centre. This system is not parallel to the present land surface, but may bear some relation to the cooling-surface of the granodiorite magma.

The only other good exposures showing jointing are in the south-east portion of the mass. At Kelly's Point the dominant jointing is in a direction E. 15° N., which is also the direction of strike of the majority of dykes here. Another set of joints runs about at right angles to this direction. Between here and Tuross Head most of the dykes, following the set of principal joints, are running in the direction E. 15° N., while west of Kelly's Point, on the shore of Coila Lake and in the neighbourhood of Bergalia, the average direction of strike varies from E. to E. 10° S.

A few less important dykes run approximately at right angles to this direction, including two narrow basaltic dykes in the western part of Kelly's Point, an aplite dyke in Por. 276, Parish of Congo, between Coila Lake and the sea, and several dyke channels through quartz-schists at Du Ross (Mullimburra) Point, which strike N. 26° W.

Thus it is evident that the chief joint system is approximately at right angles to the direction of elongation of the batholith, while jointing parallel to the direction of elongation is less perfectly developed.

(*b*) *Rift and Grain.*—The other internal evidence of tectonic stress lies in the development of the structures known as rift and grain, which are intimately associated with the slight though marked parallel arrangement of certain of the constituent minerals.

The phenomenon of "*rift*" and "*grain*" is one which has attracted the notice of geologists who have been working in granite areas in other parts of the world, for the last hundred and fifty years. It is found that usually in granitic rocks there is a certain direction, either approximately vertical or horizontal, along which the rock splits more readily than in any other direction. This direction is known as the "rift". At right angles to this there is another direction of splitting with relative ease, which is known as the "grain", whilst the direction at right angles to both "rift" and "grain" is called the "hard way".

The results of careful observations on the "rift" and "grain" in granites of the States of New England, North America, have been recorded by T. Nelson Dale (1923), who gives a detailed bibliography and a summary on rift and grain structures. It is shown that cracks through the felspar and quartz occur in the directions of the rift and grain, as well as planes of gas or liquid inclusions through quartz, pointing to an intimate relation between the arrangement of inclusions and the rift and grain structure. Moreover, porphyritic felspars may be arranged with their long axes parallel to the rift and grain, or mica plates may occur all parallel to the rift.

Sufficient has been stated to show that these structures are an expression of crustal strains and stresses during or after the consolidation of the magma, and a study of their directions may have some bearing on the tectonic history of the area.

In the Moruya district it is found that the slight parallel structure developed in the more acid members of the igneous series, is due to the parallel arrangement of the flakes of biotite and the elongation of the hornblende (if present) and plagioclase crystals in one direction in this plane. This feature is most pronounced along the eastern boundary of the batholith. At the "granite" quarries east of Moruya, the exposed granodiorite shows that this structure is parallel to the rift, which is vertical, and runs in a north-north-westerly direction. The grain is horizontal. As yet no oriented microsections are available, but some random sections of the granodiorite and granite certainly do show continuous parallel cracks extending across quartz and felspar grains and also parallel strings of tiny inclusions continuing across a number of optically independent grains of quartz, which in all probability are parallel to the rift, as determined by Dale.

(iii) *Petrography of the Plutonic Rocks.*

A large number of specimens of the plutonic rocks have been collected from all parts of the area, and have been examined in detail, and a series of chemical analyses of representatives of the chief rock-types has been carried out.

The numbers M 123, etc., refer to the specimens in the writer's collection, which has been placed in the Geological Museum of the University of Sydney.

Biotite-Granite.

The most acid members of the plutonic series are the biotite-granites occurring to the north and west of Moruya.

The granite exposed along the main road (the Prince's Highway) five miles north of Moruya, is aplitic, the rock near the actual contact with the slates, M 337, being a white crumbly graphic-granite, which powders with a blow of the hammer, and consisting of quartz and altered orthoclase with the merest trace of biotite.

Farther away from the contact is a pinkish-grey variety of granite, a medium-grained rock that has suffered considerable alteration. Under the microscope it is seen to consist of quartz and orthoclase chiefly, with some acid plagioclase and altered biotite. A small amount of muscovite is present, partly intergrown with biotite, and partly as a decomposition product of the potash-felspar. Fracture and granulation are evidences of mechanical strain.

About half a mile from the contact a more normal granite appears, which is medium-grained, and grey in colour, with massive texture. In the handspecimen, white felspar, quartz and biotite are visible. Under the microscope the rock shows a granitic texture, and is seen to consist of quartz, orthoclase, oligoclase, and microperthite, with biotite and a very small amount of muscovite, some of which is of secondary origin. Some zircon occurs in the biotite. This rock still shows signs of fracture and granulation.

About a mile west of Moruya, on the south bank of the River, the granite contains a greater amount of orthoclase and microperthite. It is interesting to note that neither in the handspecimen nor under the microscope can this rock (M 320) be distinguished from the granite outcropping at Bunnair Swamp, Conjola, about seventy miles to the north of Moruya. It is also similar to the granite outcropping a couple of miles south of Bodalla (M 398), as well as the granite from the Buckembowra district, near Nelligen (M 270).

The isolated outcrop of granite in the neighbourhood of Condoin Creek, south-west of Moruya, consists essentially of a similar acid biotite-granite (M 232), much of which has suffered considerable alteration on account of pneumatolysis, with the introduction of ores of silver, gold, arsenic and other metals. In several

localities there is a very interesting metasomatic replacement of the biotite by gold-bearing arsenical-pyrites (M 242, M 243, Baker's Shaft).

A good exposure of fresh, typical biotite-granite occurs near Heffernan's property, Portion 32, Parish of Mogendoura, on the road from Moruya to Araluen over Larry's Mountain. In the handspecimen (M 343) it appears to be a massive grey granite, medium to fine, and even-grained, consisting of quartz, white felspar and biotite.

Under the microscope it is seen to be hypidiomorphic to allotriomorphic granular, with a marked tendency to monzonitic fabric, and consists of quartz, plagioclase, orthoclase (including microperthite) and biotite, with very small amounts of apatite and zircon enclosed in the biotite.

The quartz occurs as allotriomorphic grains, either between the plagioclase crystals or else included in plates of orthoclase. It contains numerous tiny liquid inclusions, some of which contain a gaseous bubble, and which are arranged in definite lines that are continuous across a number of optically independent quartz grains. There is little doubt that this is an expression of rift and grain structure in the rock.

The plagioclase forms more or less idiomorphic prismatic crystals, about 2 mm. in diameter. It is slightly zoned and shows twinning after Carlsbad, albite and pericline laws, and is oligoclase of the composition $Ab_{78}An_{22}$.

Orthoclase is present interstitially, and as allotriomorphic plates, which enclose crystals and grains of all the other minerals, as it has been the last mineral to crystallize out, giving the rock a kind of monzonitic fabric. In most of the orthoclase there is a slight development of microperthite, as though the soda-felspar had separated out along one of the cleavage directions of the potash-felspar.

The biotite occurs as allotriomorphic flakes rarely exceeding 1·5 mm. in diameter. It has a brown colour, is strongly pleochroic, and contains small crystals of apatite and smaller needles of zircon surrounded by a pleochroic halo. A section of the rock is shown on Plate xvii, fig. i.

The chemical analysis of this rock appears below.

	Wt. p.c.	Mol. Ratios.
SiO_2	70·78	1·180
Al_2O_3	15·77	0·155
Fe_2O_3	0·69	0·004
FeO	2·44	0·034
MgO	0·72	0·018
CaO	2·53	0·045
Na_2O	2·88	0·047
K_2O	2·44	0·026
H_2O+	0·50	—
H_2O-	0·06	—
TiO_2	0·45	0·005
P_2O_5	0·25	0·001
MnO	0·08	0·001
Total	99·59	
Sp. Gr. ...	2·688	

Norm.	
Quartz	36·84
Orthoclase	14·46
Albite	24·63
Anorthite	11·68
Corundum	4·08
Hypersthene	5·23
Magnetite	0·93
Ilmenite	0·76
Apatite	0·34

Biotite-Granite, Por. 32, Par. Mogendoura, Moruya District. Anal. I.A.B. Magmatic name: Alsbachose, near Tehamose. [1, 3′, 2(3), (3)4.]

Granodiorite and Quartz-Diorite.

The granodiorites and quartz-diorites outcrop over the area extending from a short distance north of Moruya, to a point about half a mile north of Tuross Head.

A large number of specimens has been collected from all parts of the area, more than thirty of which have been sectioned and three chemically analysed. Whereas the granite occurring to the north-west is characterized by the presence of quartz, acid plagioclase (oligoclase), orthoclase, microperthite and biotite, the granodiorite and quartz-diorite consist essentially of more basic plagioclase (andesine), quartz, hornblende, biotite and very subordinate orthoclase which is merely interstitial.

There are slight differences in the texture and grainsize of different specimens of the rock, as well as minor variations in the relative proportions of the minerals present, giving differences in the body colour of the rock. In general, the rock appears to be slightly more acid in the northern and western portions of the area and may be called granodiorite, whereas the eastern and southern portions appear to be more basic, and may be designated quartz-diorite or tonalite.

Evidence of compressive crustal strain is most marked along the eastern border of the outcrop, where slight parallel arrangement of the minerals is obvious, and the dark inclusions or "basic segregations" are most abundant.

One of the best exposures of typical granodiorite is at the quarries on the left bank of the Moruya River, two miles below the town. Commercially, the stone is known as "granite", and in the past has been used in a number of the principal buildings of Sydney, including the G.P.O. and the Customs House, the material having been taken partly from these quarries, and partly from Louttit's quarry situated on the opposite bank of the river, rather nearer the mouth.

A finer grained and slightly abnormal type of granodiorite has been quarried for local purposes in portion 48, parish of Moruya, about a mile south-west of the town.

In the handspecimen, the typical rock at Dorman Long's quarry, when free of "basic segregations", is light grey in colour, and shows slight parallel arrangement of the minerals. It is evengrained, the average grainsize being 5 or 6 mm. The minerals appear to be plagioclase, quartz, biotite, hornblende and occasionally iron pyrites.

Under the microscope, the grainsize is seen to be variable, ranging from 1 mm. to 6 mm., as each of the quartz "grains" as seen in the handspecimens, actually consists of a number of smaller grains. The fabric is hypidiomorphic granular. The microscope reveals also the presence of a little orthoclase, with apatite, sphene, zircon, magnetite, ilmenite and iron pyrites as accessory minerals.

Strain is indicated by the parallel arrangement of the crystals, by fracture and granulation of the felspar and quartz grains, and by bending of the biotite.

The plagioclase is andesine, $Ab_{68}An_{32}$, occurring as subidiomorphic tabular crystals, showing twinning after Carlsbad, albite and pericline laws. It appears to have crystallized early in the cooling history of the magma, or at least to have pushed aside the grains of ferromagnesian minerals. In crush zones indicated by fracture and granulation, there is a slight development of myrmekite, where the plagioclase is in contact with orthoclase.

Quartz occurs as irregular grains between the felspar crystals, and is quite allotriomorphic. It contains tiny liquid and gas inclusions.

The hornblende crystals are prismatic, and are about 3 mm. in width, and 7 mm. in length. The mineral is dark green, and strongly pleochroic, and shows

	I.	Ia.	II.	IIa.	III.	IIIa.	IV.	IVa.	V.	Va.
Sp. Gr.	2·729	—	—	—	2·722	—	2·711	—	2·705	—
SiO_2	65·72	1·095	65·44	1·091	64·04	1·067	65·36	1·089	64·20	1·070
Al_2O_3	17·63	0·173	17·73	0·174	15·58	0·153	16·37	0·161	16·94	0·166
Fe_2O_3	0·42	0·003	1·17	0·008	0·80	0·005	1·80	0·011	2·00	0·012
FeO	2·80	0·039	3·45	0·048	4·47	0·062	2·68	0·038	2·44	0·034
MgO	1·73	0·043	1·45	0·036	2·64	0·066	1·81	0·045	2·03	0·051
CaO	4·36	0·078	3·99	0·071	3·52	0·063	3·82	0·068	4·56	0·081
Na_2O	3·14	0·051	3·58	0·058	2·42	0·039	3·40	0·055	4·00	0·064
K_2O	2·12	0·022	2·17	0·023	2·80	0·030	3·75	0·039	2·76	0·029
H_2O+	1·03	—	1·18	—	2·25	—	0·33	—	0·47	—
H_2O-	0·06	—	—	—	0·38	—	0·09	—	0·14	—
CO_2	abs.	—	—	—	abs.	—	abs.	—	0·01	—
TiO_2	0·41	0·005	0·39	0·005	0·80	0·010	0·36	0·005	0·39	0·005
ZrO_2	0·19	0·002	—	—	—	—	trace	—	abs.	—
P_2O_5	0·19	0·001	—	—	0·18	0·001	0·16	0·001	0·22	0·001
SO_3	—	—	—	—	—	—	abs.	—	0·12	—
Cl	—	—	—	—	trace	—	0·05	0·001	trace	—
F	—	—	—	—	—	—	0·14	0·008	—	—
S (FeS_2)	0·13	0·004	—	—	abs.	—	abs.	—	trace	—
Cr_2O_3	abs.	—	—	—	—	—	trace	—	trace	—
NiO, CoO	—	—	—	—	—	—	abs.	—	0·01	—
CuO	—	—	—	—	—	—	abs.	—	0·01	—
MnO	0·08	0·001	0·18	0·003	trace	—	0·16	0·002	0·07	0·001
BaO	abs.	—	—	—	—	—	0·14	0·001	0·02	—
SrO	trace	—	—	—	—	—	trace	—	trace	—
Li_2O	—	—	—	—	—	—	trace	—	abs.	—
TOTAL	100·01	—	100·73	—	99·88	—	100·42 0·07* 100·35	—	100·39	—

* O = F_2, Cl_2.

Columns Ia, IIa, etc., in this and succeeding tables give the molecular ratios.

The norms and C.I.P.W. classifications are as follow:—

	I.	II.	III.	IV.	V.
Quartz	25·92	23·34	25·14	19·20	17·52
Orthoclase	12·23	12·79	16·68	22·24	16·12
Albite	26·72	30·39	20·44	28·82	33·54
Anorthite	20·85	19·74	16·68	18·07	20·29
Corundum	2·55	2·24	2·45	—	—
Zircon	0·37	—	—	—	—
Diopside	—	—	—	—	1·14
Hypersthene	8·26	8·62	12·94	7·67	6·91
Magnetite	0·70	1·86	1·16	2·55	2·78
Ilmenite	0·76	0·76	1·52	0·76	0·76
Apatite	0·34	—	0·34	0·34	0·34
Pyrite	0·24	—	—	—	—

I. Granodiorite [Yellowstonose. I(II), 4, 3, 4], Dorman, Long and Coy.'s Quarry, Moruya. M.L.4, Parish Tomaga, Co. St. Vincent. Anal. I.A.B.

II. Tonalite [Yellowstonose. I(II), 4, 3, 4], Adamello, Tyrol. Anal. Z. Weyberg. *Neues Jahrbuch für Mineralogie*, 1912, p. 398. W.T., p. 262.

III. Granodiorite [Harzose. "II, "4, 3, 3], near Braemar House, Macedon Dist., Vict. *Geol. Surv. Vict.*, Bull. 24, 1912, p. 20. In W.T., p. 368, No. 79.

IV. "Blue Granite" [Amiatose. I(II), 4, (2)3, 3"], Tenterfield, New England, N.S.W. *Rec. Geol. Surv. N.S.W.*, 1905-9, pp. 203, 238. In W.T., p. 253.

V. "Sphene Granite" excluding orthoclase phenocrysts, Undercliffe, Wilson's Downfall, New England, N.S.W. [Yellowstonose. I(II), 4, "3, 4]. *Rec. Geol. Surv. N.S.W.*, 1905-9, pp. 209, 238 (Norm re-calculated).

In Nos. II, III and IV the norms quoted are as given in Washington's Tables.

a tendency to crystallize with the biotite in such a way that the "c" crystallographic axis of the hornblende is parallel to the plane of (001) of the biotite.

Brown, pleochroic biotite is present as allotriomorphic flakes, about 2 mm. in diameter. It shows alteration to chloritic material, and more rarely to epidote and lenses of carbonates between the cleavage lamellae, such as that described by Iddings (1911, p. 494). It contains acicular apatite, and zircon surrounded by pleochroic haloes.

A small amount of orthoclase occurs interstitially.

Idiomorphic sphene and small amounts of iron ores are scattered through the rock.

The chemical analysis of a typical specimen of this rock (M 122) is given in column I (p. 162), and a photomicrograph of a thin section on Plate xvii, fig. 2.

Considering the analysis of the Moruya granodiorite, it is found that there is less orthoclase in the mode than shown in the norm, as the potash molecule goes to form biotite; also the plagioclase is not so basic as that indicated in the norm, as some of the lime silicate combines with the ferromagnesian silicate (the hypersthene of the norm) to form hornblende in the mode. The silica percentage is slightly below that of a true granite, and the alkali percentage also shows that the rock is related to the diorites, and may reasonably be called a granodiorite.

In Column II is quoted the analysis of a tonalite from Adamello, which is remarkably similar to that of the Moruya rock. Indeed, much of the granodiorite

or quartz-diorite might appropriately be called "tonalite" as defined by Holmes (1920, pp. 227, 194) for mineralogical reasons also.

The analysis of a typical granodiorite from the Mount Macedon District, Victoria, is quoted in Column III to show the general similarity to the Moruya rock.

A study of the work on the New England granite by E. C. Andrews and other members of the staff of the Mines Department of New South Wales shows that magmatic differentiation has proceeded in New England in much the same way as it has done on a smaller scale in the Moruya District, and a number of similar rock types have been produced. For comparison with the granodiorite, the analyses of the "blue granite" from Tenterfield, and the Wilson's Downfall "sphene granite" without the orthoclase phenocrysts, are quoted in Columns IV and V.

Sphene, so characteristic of these rocks, is present also in the Moruya granodiorite and can be seen in the handspecimen, especially in the more basic types. The titania percentage is even higher than in the New England "sphene granite."

Similar granodiorites have recently been described by Buddington from Alaska (1927), and by Gillson from Idaho (1927).

Quartz-Diorite or *Tonalite.*

As stated above there are minor variations from the type, and the granodiorite grades almost imperceptibly into a true quartz-diorite or tonalite, such as that exposed at Kelly's Point.

Here it is sharply contrasted with the diorite-gabbro, which it intrudes. In the field it appears to be very similar to the granodiorite at the Moruya quarries, showing a similar parallel structure in the handspecimen, and containing abundant "basic segregations" and occasionally slaty inclusions, giving the rock a mottled appearance.

The quartz-diorite outcrops west of Mullimburra Head (Du Ross Pt.), at the Clear Hill Point, Kelly's Point, and the peninsula between Lake Coila and Lake Tuross, where it intrudes sandy micaceous schists. These localities are indicated on the accompanying map (Plate xv).

The handspecimen, when free of foreign inclusions, is dark grey, rather coarsely crystalline, and even grained, with a granitoid fabric, and appears to consist of white plagioclase, quartz, hornblende and biotite, with occasional grains of pyrites.

Under the microscope the rock is seen to have a hypidiomorphic granular fabric, very similar to that of the granodiorite, though there is less evidence of strain than in the rock at the quarry. The minerals present are plagioclase, quartz, hornblende and biotite, with subsidiary orthoclase, relatively abundant sphene, apatite, a little zircon and magnetite, and sometimes iron pyrites.

The plagioclase occurs as idiomorphic to subidiomorphic crystals about 2-3 mm. in diameter, slightly zoned, and commonly showing twinning after Carsbad, albite and pericline laws and sometimes after the Baveno law (M 175). It is andesine of the composition $Ab_{65}An_{35}$, slightly more basic than that of the granodiorite. In a few cases (*e.g.*, M 194, Clear Hill Pt.) the inner zone of felspar contains numerous small inclusions of hornblende, etc., some of which are optically continuous.

The quartz is not quite so abundant as in the granodiorite, but is otherwise similar, occurring as small allotriomorphic grains containing numerous tiny liquid inclusions, some of which contain movable gaseous bubbles.

The hornblende occurs as fairly large, well-formed crystals, green in colour and often simply twinned. It frequently occurs in intimate association with the biotite (M 217), crystallizing so that the basal plane of the biotite is parallel to the orthopinacoid of the hornblende.

Biotite is fairly abundant as small irregular grains, with some decomposition to chlorite and lenticular patches of carbonates.

A very small quantity of interstitial orthoclase is present in some sections and is almost negligible.

Apatite occurs as acicular crystals in the plagioclase and ferromagnesian minerals.

Sphene is particularly abundant as irregular grains and lozenge-shaped crystals associated with hornblende.

Iron pyrites and magnetite are both present in greater amount than in the granodiorite.

Types intermediate between the granodiorite at Moruya and the quartz-diorite or tonalite at Kelly's Point and Tuross, occur in the vicinity of Bergalia.

A specimen of quartz-diorite from Kelly's Point (M 175) was chosen for analysis, the result being given in Column I below.

	I.	Ia.	II.
SiO_2	61·44	1·024	59·47
Al_2O_3	17·61	0·173	16·52
Fe_2O_3	1·86	0·011	2·63
FeO	3·59	0·050	4·11
MgO	3·09	0·077	3·75
CaO	5·88	0·105	6·24
Na_2O	2·03	0·032	2·98
K_2O	1·03	0·012	1·93
H_2O+	1·17	—	1·39
H_2O-	0·10	—	
TiO_2	1·42	0·018	0·64
P_2O_5	0·33	0·002	—
MnO	0·09	0·001	0·08
TOTAL ..	99·64		100·00
Sp. Gr.	2·768		

Norm.	I.
Quartz	27·72
Orthoclase	6·67
Albite	16·77
Anorthite	27·24
Corundum	3·16
Hypersthene	10·60
Magnetite	2·55
Ilmenite	2·74
Apatite	0·67

I. Quartz-diorite (Tonalite), Kelly's Point, 10 miles S.E. of Moruya. Bandose nr. Tonalose ['II, (3)4, '4, 4]. Anal. I.A.B.

II. Average quartz-diorite (Osann, Washington), quoted from Daly, *Igneous Rocks*, 1914, p. 26, No. 43.

This rock is rather more basic than the granodiorite (M 122) given previously, containing more than 4% less silica, with an increase in lime, magnesia and iron, and a decrease in the amount of alkalis. The marked increase in the titania content is due to the abundance of sphene.

The analysis of the Moruya rock is very close to that of the average quartz-diorite given in Column II.

An abnormal variety of granodiorite occurs about a mile south-south-west of the Moruya Bridge, in the vicinity of Portions 48 and 49, Parish of Moruya, the property of P. Jeffery, and also on the road to Moruya Heads, in Portion 113.

The specimen described and figured by W. Anderson (1892) as being typical of the Moruya granite, is identical with this type. It is finer-grained than the typical granodiorite and is darker in colour, although it contains the same minerals: plagioclase, hornblende and biotite, with quartz, which is far less obvious in the handspecimen than in the coarser type. The rock is inclined to be porphyritic in plagioclase. It was thought that this was possibly a basic differentiate of the granodiorite, but actually its chemical composition is almost identical with that of the granodiorite (M 122).

In the field it is characterized by numerous small inclusions of darker rock, some rather angular, but many ellipsoidal in shape, having an indefinite boundary as though they had been partly digested by the host.

The peculiar habit of the quartz and plagioclase as seen under the microscope has been described by Anderson and may be seen in sections M 127 *a* and *b*. Numerous tiny rounded grains of quartz occur at the edge of the inner zone of plagioclase ($Ab_{65}An_{35}$), around which later plagioclase, of a slightly more acid variety, has been formed. The structure is not that of a true graphic intergrowth, although several grains of the quartz may extinguish simultaneously between crossed nicols. The structure seems to resemble somewhat the "quartz de corrosion" of French writers. Somewhat similar structures have been described by a number of writers, including Lacroix (1891, p. 156), Sederholm (1916, p. 64), Harker (1904, p. 186), Harker and Marr (1891, p. 278) and Andrews (1907, p. 215), but no satisfactory explanation of the phenomenon has been given. The fact that it occurs only in the neighbourhood of igneous inclusions gives some support to the idea that it is due to assimilation, and that the rock is really a hybrid. A photomicrograph of a thin section of the rock is shown on Plate xvii, fig. 3.

A very small amount of interstitial orthoclase is present.

The biotite and green hornblende both occur as ragged allotriomorphic grains about 1 mm. in diameter, which have frayed edges and contain inclusions of quartz, and occasionally felspar, giving a kind of poikilitic fabric, such as that seen in some diorites, and which is characteristic of many of the "basic segregations" in the granodiorite.

Small amounts of apatite, zircon and iron ores are scattered through the rock.

The analysis of this rock is given below.

	Wt. p.c.	Mol. Ratios.
SiO_2	65·83	1·097
Al_2O_3	16·44	0·161
Fe_2O_3	1·03	0·006
FeO	3·33	0·046
MgO	2·00	0·050
CaO	4·24	0·076
Na_2O	2·25	0·036
K_2O	3·40	0·036
H_2O+	0·67	—
H_2O-	0·10	—
TiO_2	0·78	0·009
P_2O_5	0·21	0·001
MnO	0·08	0·001
TOTAL ..	100·36	
Sp. Gr.	2·741	

Norm.	
Quartz	26·22
Orthoclase	20·02
Albite	18·86
Anorthite	20·29
Corundum	1·63
Hypersthene	9·22
Magnetite	1·39
Ilmenite	1·37
Apatite	0·34

Granodiorite, Por. 48, Parish of Moruya, Anal. I.A.B. Amiatose [I(II), 4, 3, 3].

The abundance of biotite and hornblende in the mode accounts for the rather large amount of potash calculated as orthoclase in the norm.

On comparing this analysis with that of the typical granodiorite a remarkable similarity will be observed. The relative increase in potash and iron percentages is due to the increase in the amount of biotite chiefly, which is reflected in the slightly greater specific gravity. The proportion K_2O : Na_2O places it in Amiatose next to Yellowstonose (M 122).

The slight abnormalities in the composition of this rock may have been caused by the assimilation of material such as that comprising the "basic segregations" described later, thus supporting the suggestion that, in a limited sense, the rock is a hybrid, although the dark inclusions may be co-magmatic.

Diorite-Gabbro and Hornblende-Gabbro.

The gabbro series outcrops over an area of about three square miles, between the northern part of Coila Lake and the sea-coast. To the north-west it is overlain by Tertiary sandstones and basalt, and on the south and east its outcrop is bounded by the lake or by sand-dunes. It has been intruded by the quartz-diorite as previously described, the contact being visible at Kelly's Point and at the Clear Hill Point, about a mile to the north.

In the field the diorite-gabbro appears as a dark grey holocrystalline rock of medium texture, which contains numerous segregation veins and patches, varying considerably in colour and texture. Also it is intruded by a large number of dyke rocks, including granite-aplite and pegmatite, hornblende-quartz-porphyrite, mica-lamprophyre, and an interesting variety of basaltic types, which will be described later.

By its colour and texture alone the diorite-gabbro, in the field, shows a very marked contrast with the granitic types previously described. In the hand-specimen, the rock has the appearance of a typical diorite, holocrystalline and medium-grained, consisting of black ferromagnesian mineral and white felspar in almost equal proportions. Some specimens show a small amount of iron pyrites and occasionally small well-formed crystals of sphene. The hornblende crystals show a certain amount of lustre-mottling, due to the poikilitic arrangement of the inclusions.

Under the microscope, the grainsize is seen to vary from 0·5 to 5·0 mm., the fabric is hypidiomorphic granular, with a tendency to poikilitic or subophitic.

The minerals present are chiefly hornblende and plagioclase, with very much smaller quantities of augite, biotite, orthoclase, apatite, sphene, iron pyrites and magnetite. Although the rock looks perfectly fresh in the handspecimen, small amounts of chlorite and calcite are also present.

The plagioclase is partly idiomorphic, but occurs also as small grains enclosed in the hornblende. It is well twinned, and consists chiefly of labradorite, $Ab_{47}A_{53}$, with a narrow outer zone of more acid andesine, $Ab_{65}An_{35}$.

In several instances there is a kind of graphic intergrowth of the plagioclase and the ferromagnesian minerals. One slide (M 278) shows a section of labradorite cut perpendicular to (010) and (001) in graphic intergrowth with colourless augite and brown hornblende, both partly idiomorphic, and also a skeletal form of iron ore. A photograph of this appears on Plate xviii, figs. 1 and 2.

Records of this kind of intergrowth are rare: the most similar case which has come to the notice of the writer is that of the graphic intergrowth of plagioclase and augite in a dolerite from King George Land, Antarctica, described

by W. R. Browne (1923, p. 250). Iddings (Rock Minerals, p. 238) notes a graphic intergrowth between plagioclase and orthorhombic pyroxene, and Teall (1888, Plate xxiii) illustrates a graphic intergrowth of plagioclase and augite in a dolerite from Staffordshire. This rock is described by Allport (1874, p. 549). Harker (1909, p. 270) also gives references to somewhat similar graphic intergrowths.

The hornblende is perhaps the most interesting mineral in the rock. It occurs as large subidiomorphic plates, up to 5 mm. across, and also as small crystals, less than 1 mm. in diameter. The larger plates show marked colour-zoning, the central portion being itself irregularly zoned in shades of greenish-brown, while the outer zone is of a bluish-green colour, probably indicating the presence of a certain amount of soda. The mineral is strongly pleochroic. The natural colour of the mineral does not wholly mask the interference colour. Although many of the smaller crystals are idiomorphic, the larger ones are not quite so regular, and contain inclusions of plagioclase, biotite and augite, showing that the hornblende continued crystallizing until late in the cooling history of the magma.

There can be no doubt that the hornblende is a mineral of primary crystallization, and that it has been derived partly from the colourless augite, which occurs only as small grains less than 0·5 mm. in diameter surrounded by brownish hornblende. The boundaries are often indistinct, although the minerals may be in parallel intergrowth: the change from augite to hornblende has been accompanied by the liberation of some iron oxide, shown by the association of fine magnetite dust.

Biotite in small quantity occurs in association with hornblende and iron ore.

The ferromagnesian minerals in this rock, augite, brown hornblende, green hornblende and biotite, are a good illustration of the "reaction principle" of Bowen (1922, pp. 177-198), forming as they do "discontinuous reaction series". The zoned hornblende itself may be considered as an example of "continuous reaction".

Apatite is an important accessory mineral, occurring as crystals more than 1 mm. in length, and 0·3 mm. in diameter. A few grains of interstitial orthoclase have been detected, as well as idiomorphic sphene and iron ores.

Chlorite is partly an alteration product of the biotite, and partly interstitial and deuteric. There are a few grains of interstitial calcite, which also appear to be deuteric.

A chemical analysis of the diorite-gabbro appears below (p. 170).

The hornblende-gabbro outcropping at Kelly's Point and through the beach sand, about three-quarters of a mile to the north, appears to be a local modification of the diorite-gabbro, which it resembles in many particulars. It contains all the minerals present in the diorite-gabbro (though in somewhat different proportions) and a few others in addition.

In the handspecimen, it is a black phanerocrystalline gabbroic rock, and is medium-grained. Under the microscope it is seen to have a texture similar to that of the diorite-gabbro, and consists of hornblende, plagioclase, augite, hypersthene, biotite, apatite, sphene, iron pyrites and magnetite or ilmenite, and also epidote and calcite. No olivine has been detected with certainty.

The plagioclase is not so abundant as in the diorite-gabbro, but is more basic in composition, being basic labradorite ($Ab_{35}An_{65}$) and there is a corres-

ponding increase in the proportion of ferromagnesian minerals present, the most important of which is the hornblende.

The augite occurs as grains up to 1·5 mm. in diameter, always surrounded by and changing into brownish hornblende in parallel orientation. It appears to be a normal, colourless monoclinic pyroxene. In addition, there is present a small quantity of a rhombic pyroxene, with straight extinction and marked pleochroism from pink to pale green, which is evidently hypersthene. Like the augite, it may be seen changing to hornblende. Small rounded patches of serpentinous material in the hornblende appear to be the remains of olivine grains. The hornblende is identical with that in the diorite, showing a variation in colour from dark brown or greenish-brown in the centre, to a pale bluish-green at the edges of the larger crystals and in the smaller crystals; the cleavage and twinning are like those of primary hornblende and not like those of fibrous uralite. Similarly zoned hornblende has been recorded from Garabal Hill by Wyllie and Scott (1913, p. 503). Plate xvii, figs. 5 and 6, show sections of the rock described.

Biotite is more plentiful than in the diorite-gabbro, and is of a peculiar reddish-brown colour; it appears to have formed after the hornblende on which it is moulded. Finally there is a mesostasis of faintly pleochroic epidote, having a strong double refraction, and a small amount of interstitial calcite which appears to be primary.

This rock shows then an excellent example of a "discontinuous reaction series", olivine (probably)—monoclinic and rhombic pyroxene—amphibole—mica. In the change from pyroxene to amphibole the excess of iron and lime in the pyroxene has led to the formation of magnetite as a fine dust, and of epidote and calcite as final products of consolidation of the magma.

Rosenbusch has described the production of uralite from pyroxene as being accompanied by all the phenomena which occur in the case under consideration; namely, the parallel growth of the amphibole about the pyroxene, both augite and hypersthene; the separation of fine magnetite dust, and the production of lime-rich minerals, both epidote and calcite.

There can be no doubt, however, that, in this case, the hornblende is primary, in the sense that it commenced to form as a result of the reaction of the liquid part of the magma with the already crystallized pyroxene, and later formed idiomorphic crystals; and it seems equally certain from the mode of occurrence and chemical nature of the epidote and calcite, that these also may be deuteric minerals, which have been released by the reactions during the consolidation of the magma, just as quartz may occur in quartz-dolerites and quartz-monzonites containing olivine.

Chemical analyses of the typical diorite-gabbro and hornblende-gabbro are given in columns I and II below (p. 170).

The analyses are peculiar in showing high percentages of lime and magnesia and fairly high iron oxides, which, however, might be expected from the basic character of the plagioclase, and the high content of ferro-magnesian minerals. The relatively high percentages of titania and phosphoric acid account for the abundance of sphene and apatite in these rocks.

A study of the norms of the two rocks is interesting. The diorite-gabbro contains more than 56%, and the hornblende-gabbro less than 42% of salic minerals; also the norm of the former contains 1% of quartz (which does not appear in the mode), while nearly 4% of olivine appears in the norm of the

latter. This would place both rocks near the border line of "saturated" and "under-saturated" rocks of Professor Shand (1927, p. 124). The close relationship between the diorite-gabbro and hornblende-gabbro is further indicated by their positions in adjacent rangs of the same order according to the C.I.P.W. Classification.

	I.	Ia.	II.	IIa.	III.	IIIa.	IV.
SiO_2	50·44	0·841	49·38	0·823	50·04	0·834	48·24
Al_2O_3	17·05	0·167	13·89	0·135	18·68	0·183	17·88
Fe_2O_3	2·43	0·015	1·89	0·012	0·80	0·005	3·16
FeO	5·24	0·073	6·30	0·088	6·91	0·096	5·95
MgO	10·85	0·271	15·82	0·395	7·79	0·195	7·51
CaO	9·80	0·175	10·12	0·180	9·88	0·177	10·99
Na_2O	1·51	0·024	0·54	0·009	2·35	0·038	2·55
K_2O	0·92	0·010	0·69	0·007	0·12	0·001	0·89
H_2O+	0·65	—	0·58	—	1·74	—	—
H_2O-	0·06	—	0·13	—	0·28	—	1·45
TiO_2	1·10	0·014	0·96	0·012	0·80	0·010	0·97
P_2O_5	0·43	0·003	0·30	0·002	0·16	0·001	0·28
MnO	0·11	0·001	0·14	0·002	0·14	0·001	0·13
O. Con. ...	—	—	—	—	0·89	—	—
TOTAL ..	100·59	—	100·74	—	100·58	—	100·00
Sp. Gr.	2·932	—	2·989	—	2·977	—	—

The norms are as follows:

	I.	II.	III.
Quartz	1·58	—	2·10
Orthoclase	5·56	3·89	0·56
Albite	12·58	4·72	21·13
Anorthite	36·97	33·08	40·03
Diopside	7·07	11·92	6·77
Hypersthene	29·68	37·13	27·04
Olivine	—	3·86	—
Magnetite	3·48	2·78	1·16
Ilmenite	2·13	1·82	1·52
Apatite	1·01	0·67	0·34

I. Diorite-Gabbro, Kelly's Point, Por. 215, Par. Congo. 10 mls. S.E. of Moruya. Auvergnose ["III, 5, 4, 4]. Anal. I.A.B.

II. Hornblende-Gabbro, ½ ml. N. of Kelly's Pt. Por. 290, Par. Congo. Kedabekose [III, 5, (4)5, —]. Anal. I.A.B.

III. Diorite (?), Murgatroyd's Tunnel, New England Dist., *Rec. Geol. Surv. N.S.W.*, 1905-9, Vol. 8, p. 216. Anal. J. C. H. Mingaye, Auvergnose [(II)III, 5, 4, 5].

IV. Average of all Gabbros (Osann), quoted from Daly, Igneous Rocks, 1914, p. 27, Column 52.

For comparison, the analysis of a dioritic rock from the New England District is given in column II. It is very similar to the diorite-gabbro, although

the magnesia percentage is not quite so high. Although the exact mode of occurrence of the New England rocks is not given in Mr. Andrews' paper, its association with granites, comparable in chemical character with the Moruya granodiorites and other types, including aplites and lamprophyres which have their equivalents on the South Coast, suggests a similar course of magmatic differentiation and possibly a similar structural cause.

The analysis quoted in column IV is that of the average of all gabbros, including olivine-gabbro, given by Osann, and used by Daly (1914, p. 26). The principal distinction lies in the fact that the average gabbro contains more lime than magnesia, whereas the reverse is true in the case of each of the rocks from Moruya.

Nomenclature of the Basic Plutonic Rocks.

The peculiar chemical nature and mineral constitution of the so-called diorite-gabbro demands some comment, and the name requires some justification. In the handspecimen the rock has a typical "dioritic" appearance, being medium-grained and containing nearly equal proportions of light and dark-coloured minerals. Under the microscope it is found that the felspar is labradorite, $Ab_{47}An_{53}$, and the chief ferro-magnesian mineral is hornblende.

According to Harker (1908) the rock would be classified as "hornblende diorite". Other petrologists, such as Daly (1909) and Iddings (1909, Vol. I, p. 376) would call it rather "hornblende gabbro" on account of the calcic nature of the plagioclase. Also, as the silica percentage is less than 52, it would be placed in the gabbro family by Hatch (1914, pp. 195, 216).

The high percentages of lime and magnesia certainly indicate an affinity with the gabbros. It has already been seen that similar difficulty would be encountered in classifying it according to Professor Shand's scheme.

On the whole, it is considered that the name "diorite-gabbro" conveys the best idea of its characteristics, and distinguishes it from the allied but more basic hornblende-gabbro.

Segregation Veins and Patches in the Gabbros.

Reference has already been made to the variety of differentiation products occurring as veins and irregular patches through the diorite-gabbro, caused by the activity of magmatic solutions during the later stages of consolidation of the magma.

These segregations are usually more coarsely grained than the enclosing rock, but are not invariably so; as a rule they are lighter in colour than the gabbro, on account of the predominance of felspar over the ferro-magnesian minerals: they are thus of the nature of pegmatites and aplites. Occasionally, however, the dark minerals preponderate and there is developed a kind of lamprophyric rock.

In all cases the actual boundaries of the segregations are irregular and ill-defined. Sometimes veins of felspathic material about 1 mm. in thickness may extend from the segregation for a short distance along joint planes through the diorite-gabbro, but there is every reason for believing that the formation of these segregations took place when the diorite-gabbro was still hot, and not entirely consolidated, and in fact that the segregations represent the final stages of consolidation of the gabbroic magma.

Two varieties of coarse-grained pegmatities are worthy of note: one is characterized by abundance of orthoclase, and the other by plagioclase. The orthoclase-bearing rock occurs in the diorite-gabbro on a small headland about a quarter of a mile south of Kelly's Point. The rock (M 309) is coarse and even-grained, the absolute grainsize being more than 1 cm. It consists of approximately 65% of pink orthoclase, 25% of black, idiomorphic hornblende, and 10% of white oligoclase, of the composition $Ab_{85}An_{15}$. A small quantity of iron pyrites is present.

On the southern side of the cliffs half a mile north of Kelly's Point, several veins of coarse felspathic material, somewhat similar to this rock, again occur through the diorite-gabbro. The ferro-magnesian constituent is practically absent, and the vein consists of about 95% of pink orthoclase, and the rest of white glassy plagioclase.

By far the more common type of pegmatite is that consisting chiefly of white plagioclase and black, idiomorphic hornblende, which may reach a length of 4 cm. Some orthoclase is usually present, and also relatively large grains of sphene. The plagioclase is oligoclase, $Ab_{80}An_{20}$.

Another interesting type of segregation is that developed on the southern part of Kelly's Point, which has the appearance of a hornblende-lamprophyre. It occurs in irregular patches, and consists of black hornblende in stumpy crystals about 5 mm. in thickness, and comprising about 40% of the rock, set in a dark greenish groundmass of finely crystalline material. Under the microscope the hornblende shows characters similar to that in the gabbros, being colour-zoned, and containing remnants of augite. The groundmass consists of andesine and colourless augite in almost equal proportions, with some green hornblende, sphene, apatite and interstitial epidote.

Inclusions in the Granodiorite.

There are numerous dark inclusions and "basic segregations" in some parts of the granodiorite and tonalite, particularly along the eastern and southern portions of their outcrops. Narrow veins of the granodiorite frequently intrude the inclusions, and aplite veins traverse host and inclusion alike.

These inclusions may be divided into two classes, (*a*) rocks of sedimentary origin, and (*b*) igneous rocks.

(*a*). The first class contains almost exclusively fragments of quartz-schists, which vary in size from a few inches to several feet in diameter. These inclusions are generally angular, and retain distinct evidence of original bedding similar to that of the intruded quartz-schists of the district. The schist appears to have sharp boundaries against the granodiorite. Under the microscope it is seen to be entirely crystalline, and to consist of quartz, a greenish-brown mica and some plagioclase.

Inclusions of this class are undoubtedly fragments of country rock included in the intrusive igneous mass, and are thus "accidental xenoliths".

(*b*). The rocks included in the second class call for closer consideration. At Moruya these inclusions are far more abundant than those belonging to the first class. There is no doubt that they are not true segregations or secretions which have crystallized in the position in which they are now found, although it is possible that they may have exerted some such influence upon the crystallization of the adjacent rock as that postulated by Bowen (1922, p. 539).

This type of inclusion is usually spheroidal, and consists of a rock which is more finely grained than the normal granodiorite or tonalite. It is really a quartz-mica-diorite. Frequently phenocrysts of plagioclase and poikilitic flakes of biotite are present (Plate xvii, fig. 4). A typical specimen consists of plagioclase, biotite, green hornblende, interstitial quartz, and a small amount of interstitial orthoclase, iron ore, acicular crystals of apatite, with occasional sphene, zircon and iron pyrites. The peculiar habit of the ragged flakes of biotite enclosing crystals of other minerals, notably felspars, in a poikilitic manner, is quite characteristic, and resembles the structure of some normal mica-diorites.

The following is the chemical composition of a typical specimen of this class of inclusion.

SiO_2	58·58	0·976
Al_2O_3	18·33	0·179
Fe_2O_3	1·96	0·012
FeO	5·01	0·069
MgO	3·69	0·092
CaO	6·14	0·110
Na_2O	1·99	0·032
K_2O	1·28	0·014
H_2O+	1·44	—
H_2O-	0·09	—
TiO_2	1·06	0·014
P_2O_5	0·30	0·002
MnO	0·19	0·003
TOTAL ..	100·06	
Sp. Gr.	2·808	

Norm.	
Quartz	21·36
Orthoclase	7·78
Albite	16·77
Anorthite	28·63
Corundum	3·06
Hypersthene	15·27
Magnetite	2·78
Ilmenite	2·13
Apatite	0·67

Basic Inclusion in Granodiorite, Quarry near Moruya, M.L.4, Par. Tomaga. Bandose [II, 4, "4, 4]. Anal. I.A.B.

A comparison of this analysis with that of the granodiorite shows that there is the same order of difference in the chemical characters of the inclusion and host as that which has been observed by Harker and Marr (1891, p. 279), Phillips (1880, p. 1), and others.

With a relative decrease in the amount of silica and alkalis in the inclusion, there is a corresponding increase in the amounts of iron, lime and magnesia.

On reference to the variation-diagram for the plutonic complex, given on page 183, it will be seen that the composition of a hypothetical member of the complex containing 58½ per cent. of silica, is remarkably close to that of the included quartz-mica-diorite. It therefore seems quite probable that the host and inclusion are co-magmatic, and that the quartz-mica-diorite represents an early-formed member of the igneous series, which was shattered and included in the granodiorite during its injection into its present position.

These "basic segregations" are therefore really "cognate xenoliths".

(iv). *Field Occurrence and Petrography of the Dykes.*

Associated with the Moruya plutonic complex and the related sediments are several systems of dykes, some of which are clearly hypabyssal equivalents of the plutonic series, and others whose relationships are more obscure. Individual dykes vary in width from one or two feet to about twelve or fourteen feet, but the majority average a thickness of about four feet, and they are generally vertical.

In some areas they are very numerous, although individual dykes cannot usually be traced for any great distance, on account of surface weathering.

The directions of strike of the dykes seem to bear a definite relation to the lithological character of the dyke, and are probably dependent on the directions of crustal strain and stresses acting prior to and during the time of their injection. For this reason it will be convenient to consider them in the following order, which is probably the order of their intrusion.

(1) Muscovite-granite apophysis.
(2) Granite-aplites and pegmatites, including graphic pegmatite.
(3) Hornblende-quartz-porphyrite and granite-porphyry.
(4) Mica-lamprophyre.
(5) A variety of intermediate and basic types.

(1) A dyke of muscovite-biotite-granite occurs in the Moruya Council's metal quarry at Yarragee, about a mile west of Moruya, where it intrudes vertically bedded and banded quartz-schists, along their direction of strike, which is almost north and south. It is about four feet in width and consists of granite very similar to the border phases of the biotite-granite in the main batholith.

In thin section the rock shows a rather coarsely crystalline texture, and the grainsize is variable; it is granitoid and shows evidence of considerable strain. It consists of quartz as irregular interlocking grains, acid plagioclase (oligoclase), orthoclase and microperthite similar to that in the biotite-granite, with abundant muscovite in parallel intergrowth with biotite. The biotite contains numerous tiny, dark brown haloes, in the centre of which a crystal of zircon may occasionally be detected. A small amount of iron ore is present. It is noteworthy that muscovite does not occur in the biotite-granite normally, except in some of the border phases and apophyses.

(2) The granite-aplites and pegmatites show some variation in composition and texture; they usually intrude the granodiorite and tonalite, but they also occur in the diorite-gabbro.

There is greater variation in the direction of strike and the amount of dip in the case of the aplites than in any of the other dyke-rocks. In the quarry on the north side of the Moruya River, narrow veins of aplite, less than one inch in thickness, traverse the granodiorite, dipping in a direction N. 45° E. at about 45°, which is parallel to the direction of strike of the principal joint system in the granodiorite. Veins of this type may be seen in the granite columns of the G.P.O., Sydney. In the quarry on the southern side of the River (Louttit's), there are four or five veins of aplite about one inch in thickness, and from three to eight feet apart, as well as a dyke two feet in thickness, which dip S. 40° W. at 50°.

These veins always cut through the slaty and other inclusions in the granodiorite.

There is a series of eight or nine fine-grained aplitic dykes on the shore of Lake Coila about a mile north of the Bar. They average about two feet in width, and are only a few yards apart, running in a direction W. 20° N. Half a mile to the north are numbers of smaller aplite veins. Several aplite dykes intrude the tonalite of the Tuross peninsula, between Lakes Coila and Tuross, running in a direction N. 60° E. and others occur between Lake Coila and the sea. One dyke in portion 294, Parish of Congo, appears to have been faulted at right angles, resulting in the concentration of ground water at the intersection of dyke and fault, with the formation of a small spring or permanent soakage.

South of Kelly's Point there are two well-defined dykes which dip to the north at 60°, and form prominent outcrops through the beach-sand; one has weathered to a yellow colour and the other is red.

The widest aplite dyke is that at Kelly's Point, indicated on the sketch-map on page 153. It is about twelve feet thick and dips to the north-east at 40°, but is not constant in direction as it swings round to the north. It has intruded the tonalite, which in turn has intruded the diorite-gabbro, but is intruded by the later basaltic dykes. Unweathered specimens of this dyke were chosen for analysis as being representative of the aplites.

The microscope shows it to be a fine-grained and aplitic rock, consisting of quartz, acid plagioclase and some biotite, with abundant interstitial orthoclase, which has been the last mineral to crystallize out. No muscovite has been observed in this particular rock, although some of the other aplites contain small amounts of both biotite and muscovite, while in others there is a complete absence of any minerals other than quartz, orthoclase and acid plagioclase.

The chemical analysis of this aplite is quoted below.

	I.	Ia.	II.	IIa.
SiO_2	77·92	1·299	74·00	1·233
Al_2O_3	11·99	0·118	14·49	0·142
Fe_2O_3	0·21	0·001	1·10	0·007
FeO	0·74	0·010	0·45	0·006
MgO	0·24	0·006	0·44	0·011
CaO	1·23	0·021	0·92	0·016
Na_2O	2·29	0·037	3·29	0·053
K_2O	4·78	0·051	4·85	0·051
H_2O+	0·26	—	0·56	—
H_2O-	0·14	—	0·18	—
CO_2	abs.	—	abs.	—
TiO_2	0·18	0·003	0·14	0·002
P_2O_5	0·03	—	0·05	—
MnO	trace	—	0·08	0·001
BaO	—	—	0·06	0·001
TOTAL	100·01	—	100·61	—
Sp. Gr.	2·646	—	2·630	—

Norms.	I.	II.
Quartz	43·02	33·84
Orthoclase	28·36	28·36
Albite	19·39	27·77
Anorthite	5·84	4·73
Corundum	0·92	2·14
Hypersthene	1·39	1·10
Magnetite	0·23	1·16
Ilmenite	0·46	0·30
Haematite	—	0·32

I. Aplite, Kelly's Point, 10 mls. S.E. of Moruya. Anal. I.A.B. Tehamose [I, 3, 2, "3].

II. Aplitic Granite, 2 mls. E. of Tenterfield. Anal. J. C. H. Mingaye. *Rec. Geol. Surv. N.S.W.*, viii, Pt. 3, 1905-9, p. 225. Tehamose [I, 3(4), (1)2, 3]. Norm re-calculated.

The rock is a normal aplite. The analysis of an aplitic granite belonging to the euritic period in the history of the New England Tableland intrusions is quoted in Column II to show the close resemblance to the Moruya rock. Some of the acid granites from Bolivia are also very similar.

It will be shown later that the rock bears a close magmatic relation to the plutonic types comprising the batholith, and was probably injected shortly after their consolidation.

A beautiful example of graphic pegmatite occurs as a dyke on the south-western shore of Lake Coila, in portion 39, Parish of Congo. It consists of crystals of yellowish-pink orthoclase, averaging two inches in diameter, and white acid plagioclase, both graphically intergrown with quartz. Flakes of biotite about half an inch in diameter are associated with the plagioclase. Under the microscope the orthoclase shows also a fine perthitic intergrowth with plagioclase.

(3) Dykes of the third class, the hornblende-quartz-porphyrites, have a very wide distribution, occurring throughout the whole of the mapped area, and intruding all phases of the igneous complex, as well as the adjacent slate series. It was found quite impracticable to indicate all of these dykes on the map, as several hundred must occur in the district.

The greater number run in a direction slightly north of east, although a few run approximately E. 30° N. and some strike E. 30° S. As a result of weathering, the positions of the dykes (which frequently occur in groups) may be indicated by a series of parallel trenches, or by a series of parallel rock-ridges, depending on the relative resistance to weathering of the intruded and intrusive rock. The dykes are rarely more than a few feet in width.

The consistent and characteristic alteration of the rock itself, suggests that such is due not merely to surface weathering, but to magmatic processes which have accompanied or closely followed the dyke formation. It is difficult to obtain a specimen which looks really fresh. The freshest specimens are dark grey in colour, but on weathering the rock becomes light greenish-grey.

Often the rock is very fine-grained, so that only crystals of hornblende can be distinguished from the lithoidal groundmass. Coarser varieties show elongated phenocrysts of hornblende or hornblende and plagioclase, never exceeding a few millimetres in length, set in a phanerocrystalline groundmass.

Under the microscope, these rocks are seen to be holocrystalline, slightly porphyritic in plagioclase and hornblende or its pseudomorphs. The phenocrysts are set in a fine-grained or even microcrystalline groundmass, consisting chiefly of plagioclase and quartz and the remains of hornblende grains, with a small amount of biotite and muscovite. The fineness of grain of the groundmass makes it difficult to recognize the variety of plagioclase, or the presence of orthoclase with any degree of certainty.

The hornblende phenocrysts are idiomorphic, and very seldom fresh. Such as are fresh have a greenish-brown colour approaching that of basaltic hornblende. A characteristic feature is the alteration to grains of clear carbonate material, including calcite, and colourless or pale green epidote, with associated iron ore. Green chloritic material showing prussian-blue interference colours occurs in some cases. The plagioclase phenocrysts are andesine, Ab_{65} An_{35}.

The groundmass consists of an intimate association of felspar, chiefly plagioclase, and quartz. In some cases the felspars occur as stout little prisms with quartz filling the interstices, in other cases (M 123, M 206) there is a micrographic intergrowth of the quartz and felspar, producing a kind of granophyric structure.

Occasionally the structure is micropoikilitic, quartz grains forming a matrix for smaller, optically independent grains of felspars.

Alteration products such as epidote, chlorite, calcite and iron ore are scattered through the groundmass, and a pale yellow variety of sphene and some apatite crystals are present in some sections.

It will be seen that the rock (Plate xviii, fig. 3) is a peculiar type. As a field name "lamprophyre" seems appropriate, and the alteration of hornblende to carbonates and epidote is certainly characteristic; but there is an unusually high percentage of quartz present in the groundmass, which probably indicates peculiar conditions of crystallization.

A specimen from a dyke cutting across the main road about half a mile north of Bergalia Store and Post Office, was selected for chemical analysis, as being relatively fresh and representative of the series. The result is given in Column I below.

	I.	Ia.	II.	IIa.
SiO_2	66·11	1·102	69·33	1·155
Al_2O_3	17·26	0·169	15·23	0·149
Fe_2O_3	0·63	0·004	0·97	0·006
FeO	2·68	0·037	2·56	0·035
MgO	1·41	0·035	1·01	0·025
CaO	4·72	0·084	3·74	0·067
Na_2O	2·11	0·034	2·73	0·044
K_2O	1·02	0·011	1·42	0·015
H_2O+	1·72	—	1·56	—
H_2O-	0·10	—	0·18	—
CO_2	1·22	0·027	abs.	—
TiO_2	0·49	0·006	0·94	0·012
P_2O_5	0·13	0·001	0·06	0·001
MnO	0·12	0·001	0·11	0·001
TOTAL	99·72	—	99·84	—
Sp. Gr.	2·719	—	2·711	—

Norms.	I.		II.
Quartz	39·66	..	37·80
Orthoclase	6·12	..	8·34
Albite	17·82	..	23·06
Anorthite	15·01	..	17·79
Corundum	7·14	..	2·65
Hypersthene	7·20	..	4·88
Magnetite	0·93	..	1·39
Ilmenite	0·91	..	1·82
Apatite	0·34	..	0·34

I. Hornblende-quartz-porphyrite. Dyke, ½ ml. N. of Bergalia. Anal. I.A.B. Susquehannose [I(II), 3, 3, 4].

II. Granite-porphyry. Condoin Creek, Por. 33, Par. Bergalia, Anal. I.A.B. Susquehannose [I, 3″, 3, 4].

The chemical composition thus shows a remarkable similarity to that of the typical granodiorite from Dorman, Long and Company's quarry, the main difference being that the percentage of alkalis is lower (by two per cent.) in the dyke rock. This is reflected by a decrease in the amount of felspar with a corresponding increase in the amount of quartz in the norm. As a result the rocks are placed in corresponding subrangs of adjacent orders according to the C.I.P.W. classification.

Somewhat similar rocks are described by Iddings (1891, p. 588) from Electric Peak in the Yellowstone Park, and called by him "porphyrites" of various kinds. The chemical analyses of these rocks show a similar percentage of silica but the alkalis exhibit a slightly higher percentage than in the Moruya rock.

Similar dyke-rocks of Palaeozoic age in the Cape Colville Peninsula in the North Island of New Zealand have been described by Professor Sollas (1905, p. 119) as porphyrites, but unfortunately no chemical analyses are available. The frequent alteration of hornblende to epidote is specially noticed in these rocks.

The nomenclature of the Moruya dyke-rocks has been the subject of serious consideration, and it seems that the name "hornblende-porphyrite" or "hornblende-quartz-porphyrite" would be most appropriate for these peculiar types.

The analysis given in Column II is that of a granite-porphyry intruding the biotite-granite at Condoin Creek, south-west of Moruya, in portion 33, Parish of Bergalia. Its composition is close to that of the hornblende-quartz-porphyrite.

The mode of occurrence is somewhat obscure, as the outcrops are poor. As far as can be ascertained it occurs as a dyke or small stock near the border of the granite.

In the handspecimen, phenocrysts of plagioclase, quartz and biotite are set in a lithoidal groundmass.

Under the microscope, the plagioclase is seen to be oligoclase of the composition $Ab_{75}An_{25}$, and the groundmass is holocrystalline and consists of felspar, quartz, biotite, green hornblende, iron ore and a little orthoclase and apatite.

(4) Mica-lamprophyre outcrops on the shore of Lake Coila in portion 295, Parish of Congo, as a vertical dyke, two feet in width, running in a direction W. 20° N., parallel to the series of associated dykes of aplite, hornblende-porphyrite and more basic types, which are intruding the diorite-gabbro in this locality.

The rock shows the characteristic weathering of a lamprophyre, the colour of the fresh rock being light greenish-grey, which changes to a reddish-brown shade on weathering.

Idiomorphic biotite is the only mineral visible in the handspecimen. It is very abundant and gives a kind of schistose appearance to the rock.

Under the microscope a few grains of altered plagioclase may be seen in addition to biotite, which contains abundant grains of iron ore. The groundmass is microcrystalline and probably felspathic (Plate xviii, fig. 4).

Its chemical composition has not been determined, so that its genetic relationship with the igneous complex cannot be proved. The occurrence of similar lamprophyres is rather characteristic of the closing phases of igneous activity in many parts of the world. The susceptibility of this type of rock to rapid weathering probably accounts for the fact that no other dykes of a similar character have been observed in the district.

(5) Rocks of a basaltic appearance occur as vertical, or steeply inclined dykes intruding all phases of the igneous complex, and also the altered sedimentary series. The width of the dykes varies from two and a half to twelve feet, the

majority being about four feet wide; the direction of strike varies from N. 50° E. to E. 10° S. The general trend is about E. 10° N.

The majority of these dyke-rocks are finely grained and dark-coloured, not markedly porphyritic, although there are a few rather striking exceptions. In the handspecimen they may be readily distinguished from the Tertiary basalts, occurring as interbedded flows or sills in the later sediments.

Petrographically, there seems to be a fair amount of variation in these basaltic-looking rocks. Some specimens show resemblances to the rocks previously described as hornblende-quartz-porphyrites. The rocks are always holocrystalline, and usually slightly porphyritic. The phenocrysts consist of plagioclase or hornblende in some cases, or in a few cases they are of colourless augite and pseudomorphs after olivine. The groundmass is generally medium-grained, and consists of plagioclase and green hornblende, with a small amount of quartz and accessory minerals, apatite and iron ore.

Associated with these basaltic rocks are a few unusual types which deserve special mention, but which are reserved for detailed description in a later communication. These outcrop at Kelly's Point and on the shore of Lake Coila. They contain xenoliths of basic plutonic rocks, and xenocrysts of plagioclase, biotite, brown hornblende, augite and dark red garnet.

It is considered that the dykes belonging to the first three groups certainly belong to the later stages of the Palaeozoic igneous activity in this area, and are magmatically related to the plutonic series; there is insufficient evidence for assigning an age to the mica-lamprophyre; while some of the basaltic types containing green hornblende are probably related to the granodiorites, others, particularly those containing large xenocrysts, may be of much later origin.

(v). *Petrogenesis of the Palaeozoic Igneous Rocks.*

(*a*) *Genetic Relationships.*

The field relations and associations of the Palaeozoic igneous rocks naturally lead to the consideration of their magmatic relationships. There is a wide range of rock types from acid to basic, and from plutonic to hypabyssal or volcanic types. The field evidence suggests some magmatic relationships, in that the main intrusion takes the form of a complex batholith in which the later injections of magma have been progressively more acid than the earlier ones. Acid aplite dykes probably represent the later phases of consolidation of the injected magma. Subsequent strains and stresses have caused the development of joints and other planes of weakness, along which dykes of hornblende-quartz-porphyrite and then basaltic and lamprophyric rocks have been injected.

The general sequence therefore, is such as might be expected in a complete igneous complex.

The mineralogical composition confirms this supposition. For the sake of clearness and simplicity a table is given below showing the mineralogical composition of all the rocks which have been chemically analysed, which comprise most of the principal types described. The rocks are arranged in order of decreasing basicity. It will be seen that the order of crystallization of the minerals present shows a similar order of decreasing basicity.

The ferromagnesian minerals, with the exception of biotite, are more abundant in the basic members of the system; some biotite is present throughout the whole series, with a notable increase in amount towards the acid end. The plagioclases by themselves form a definite index of the composition of the rock; the oldest

rocks, the gabbro and gabbro-diorite, are characterized by labradorite of fairly constant composition, the tonalite and granodiorite show a variation from andesine to oligoclase-andesine, while the later biotite-granite contains oligoclase of a constant composition. Orthoclase is important only in the biotite-granite and aplite, although smaller quantities do occur in the more basic types. Quartz is present in all but the basic types, increasing in abundance in the acid members.

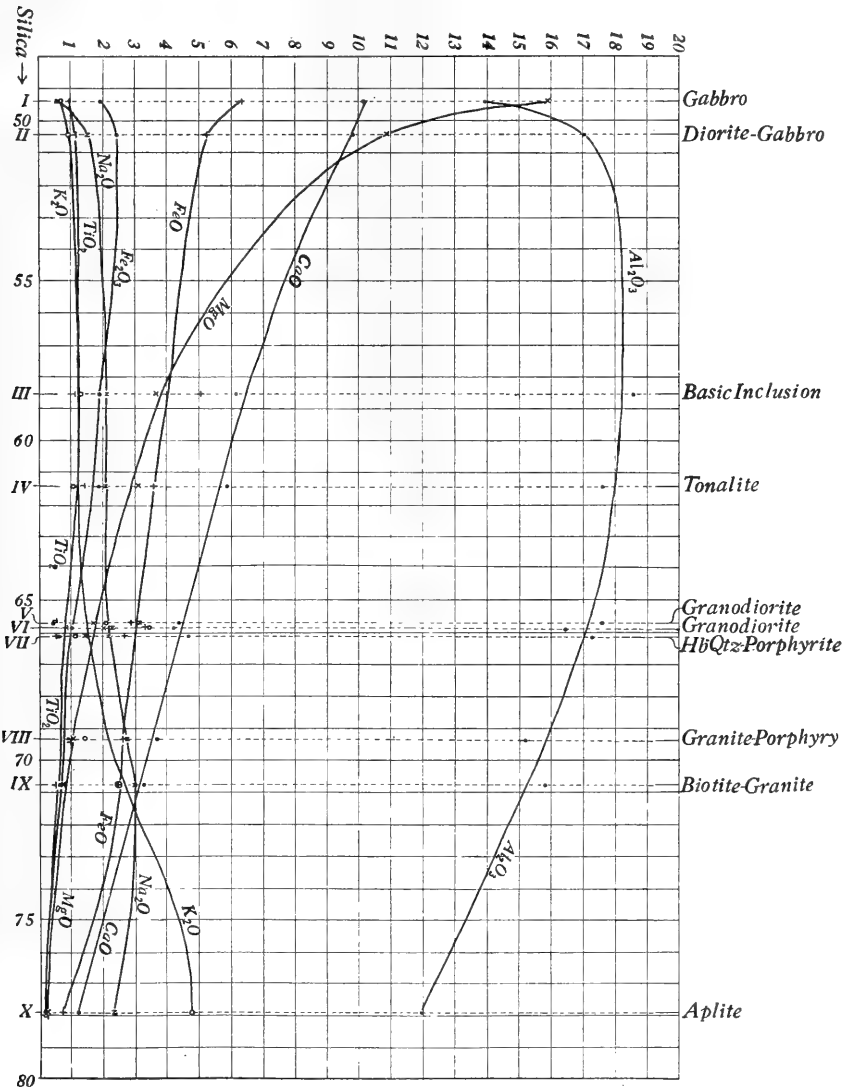
	I. Hornblende-Gabbro.	II. Diorite-Gabbro.	III. Basic Inclusion.	IV. Tonalite.	V. Granodiorite.	VI. Granodiorite.	VII. Hb.-qtz.-Porphyrite.	VIII. Granite-Porphyry.	IX. Biotite-Granite.	X. Aplite.
Iron Ore	+	+	+	+	+	+	+	+	+	—
Olivine	?	—	—	—	—	—	—	—	—	—
Hypersthene	+	—	—	—	—	—	—	—	—	—
Augite	+	+	—	—	—	—	—	—	—	—
Brown Hornblende ..	+	+	—	—	—	—	?	—	—	—
Green Hornblende ..	+	+	+	+	+	+	?	+	—	—
Biotite	+	+	+	+	+	+	+	+	+	+
Muscovite	—	—	—	—	—	—	+	—	—	?
Labradorite	+	+	—	—	—	—	—	—	—	—
Andesine	—	—	?	+	+	+	+	—	—	—
Oligoclase	—	—	—	—	—	—	—	+	+	+
Orthoclase	—	+	+	+	+	+	?	+	+	+
Quartz	—	—	+	+	+	+	+	+	+	+
Sphene	+	+	+	+	+	+	+	—	—	—
Apatite	+	+	+	+	+	+	?	+	+	?
Zircon	—	—	+	+	+	+	—	?	+	—
Epidote	+	—	—	—	—	—	+	—	—	—
Calcite	+	—	—	—	—	—	+	—	—	—

Of the accessory minerals, iron ore and apatite occur in small quantities throughout; sphene is in greater abundance than is usual, especially toward the

basic end of the series, and zircon is relatively important in the granodiorite and biotite-granite.

Epidote and calcite occur in unweathered specimens of the gabbro and the hornblende-quartz-porphyrite alone, where they are undoubtedly minerals of late-magmatic or deuteric crystallization.

The chemical evidence is probably the most convincing in proving the consanguinity of the rocks under consideration. A table of the chemical analyses of



Text-fig. 4.—Variation diagram for the igneous complex of the Moruya district.

all the rocks from this district, which have been analysed by the writer, is given below in the same order as in the mineralogical table, thus including the chief plutonic types, some of the important dyke rocks, and a cognate xenolith from the granodiorite.

It will be seen that on the whole there is a gradation throughout the series for each of the constituent oxides. This has effected a corresponding variation in the values of the specific gravities, which are quoted below the analyses.

A table of the calculated norms further bears out the consanguinity of the various members of the series, which is emphasized in the table of their classifications by the regular gradation in class, order, rang and subrang alike.

The ten chemical analyses have been plotted to form a variation-diagram (Text-fig. iv) of the type used by Harker (1909, p. 129), where the silica percentages are used as abscissae, giving a range of nearly 30 per cent., and the percentages of the other oxides are plotted as ordinates. Smoothed curves have been drawn through the mean positions of these points.

The curves thus obtained give the best picture of the series as a whole, showing without doubt the genetic relationships of the series, which forms a true plutonic complex, including basic, intermediate and very acid types.

A consideration of the form of each of the curves representing the various oxides shows that the series is a typical subalkaline or calcic assemblage, characterized by the flat convex curve for alumina, concave declining curve for magnesia, and declining curves, almost straight lines, for lime and iron oxides; the curves for the alkalis, particularly potash, show a rise from the basic to the acid end of the series. Another feature shown by the analyses is the relative importance of titania: in the basic gabbro the amount of titania is greater than that of either soda or potash.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
SiO_2	49·38	50·44	58·58	61·44	65·72	65·83	66·11	69·33	70·78	77·92
Al_2O_3	13·89	17·05	18·33	17·61	17·63	16·44	17·26	15·23	15·77	11·99
Fe_2O_3	1·89	2·43	1·96	1·86	0·42	1·03	0·63	0·97	0·69	0·21
FeO	6·30	5·24	5·01	3·59	2·80	3·33	2·68	2·56	2·44	0·74
MgO	15·82	10·85	3·69	3·09	1·73	2·00	1·41	1·01	0·72	0·24
CaO	10·12	9·80	6·14	5·88	4·36	4·24	4·72	3·74	2·53	1·23
Na_2O	0·54	1·51	1·99	2·03	3·14	2·25	2·11	2·73	2·88	2·29
K_2O	0·69	0·92	1·28	1·03	2·12	3·40	1·02	1·42	2·44	4·78
H_2O+	0·58	0·65	1·44	1·17	1·03	0·67	1·72	1·56	0·50	0·26
H_2O-	0·13	0·06	0·09	0·10	0·06	0·10	0·10	0·18	0·06	0·14
TiO_2	0·96	1·10	1·06	1·42	0·41	0·78	0·49	0·94	0·45	0·18
P_2O_5	0·30	0·43	0·30	0·33	0·19	0·21	0·13	0·06	0·25	0·03
MnO	0·14	0·11	0·19	0·09	0·08	0·08	0·12	0·11	0·08	Tr.
Other constituents .	—	—	—	—	0·32	—	1·22	—	—	—
TOTAL ..	100·74	100·59	100·06	99·64	100·01	100·36	99·72	99·84	99·59	100·01
Sp. Gr.	2·989	2·932	2·808	2·768	2·729	2·741	2·719	2·711	2·688	2·646

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
Quartz	—	1·38	21·36	27·72	25·92	26·22	39·66	37·80	36·84	43·02
Orthoclase .	3·89	5·56	7·78	6·67	12·23	20·02	6·12	8·34	14·46	28·36
Albite	4·72	12·58	16·77	16·77	26·72	18·86	17·82	23·06	24·63	19·39
Anorthite ..	33·08	36·97	28·63	27·24	20·85	20·29	15·01	17·79	11·68	5·84
Corundum .	—	—	3·06	3·16	2·55	1·63	7·14	2·65	4·08	0·92
Zircon	—	—	—	—	0·37	—	—	—	—	—
Diopside ..	11·92	7·07	—	—	—	—	—	—	—	—
Hypersthene	37·13	29·68	15·27	10·60	8·26	9·22	7·20	4·88	5·23	1·39
Olivine	3·86	—	—	—	—	—	—	—	—	—
Magnetite .	2·78	3·48	2·78	2·55	0·70	1·39	0·93	1·39	0·93	0·23
Ilmenite ...	1·82	2·13	2·13	2·74	0·76	1·37	0·91	1·82	0·76	0·46
Pyrite	—	—	—	—	0·24	—	—	—	—	—
Apatite	0·67	1·01	0·67	0·67	0·34	0·34	0·34	0·34	0·34	—
Class	III	"III	II	'II	I(II)	I(II)	I(II)	I	I	I
Order	5	5	4	(3)4	4	4	3	3"	3'	3
Rang	(4)5	4	"4	"4	3	3	3	3	2(3)	2
Subrang ...	.—	4	4	4	4	3	4	4	(3)4	"3
Magmatic Name.	Kedabekase.	Auvergnose.	Bandose.	Bandose (nr. Yellowstonose).	Yellowstonose.	Amiatose (nr. Yellowstonose).	Susquehannose (nr. Yellowstonose).	Susquehannose (nr. Yellowstonose).	Alsbachose (nr. Tehamose).	Tehamose.

I. Gabbro (M.109). Kelly's Point, south-east of Moruya.
II. Diorite-gabbro (M.278). Kelly's Point.
III. Inclusion in Granodiorite (M.121). Quarry, 2 mls. E. of Moruya.
IV. Tonalite (Quartz-Diorite). (M.175). Kelly's Point.
V. Granodiorite (M.122). Quarry, 2 mls. E. of Moruya.
VI. Granodiorite (M.127). 1 mile south-west of Moruya.
VII. Hornblende-quartz-Porphyrite (M.123). Dyke, near Bergalia.
VIII. Granite-porphyry (M.233). Condoin Creek, south-west of Moruya.
IX. Biotite-Granite (M.343). 3 mls. north-west of Moruya.
X. Aplite (M.105). Dyke, Kelly's Point, 10 mls. south-east of Moruya.

There is a marked similarity between the series at Moruya and the classic series at Garabal Hill, which was described by Dakyns and Teall (1892, pp. 104-121) and later by Wyllie and Scott (1913).

In the case of Garabal Hill the silica percentages range from 38·6 to 75·8, and thus differ slightly from those at Moruya. Within the latter limits the modified variation-diagram for the Garabal Hill series, as given by Harker (1909, p. 129), bears a striking resemblance to that of the Moruya series. The only real difference is the relatively sudden change in the amount of curvature of the oxide-curves between the diorite-gabbro and the more basic gabbro at Moruya, which is suggestive of complementary, as opposed to serial differentiation. This idea is supported by the nature of the field occurrence of the hornblende-gabbro. Nevertheless the senses or directions of curvature in the basic ends of both the Garabal Hill and the Moruya series are similar.

(*b*). *Shape and Nature of the Intrusion.*

The intrusive nature of the igneous mass may be seen at its junction with quartz-schists, about half a mile east of Dorman, Long and Co.'s main quarry, M.L.4, Parish of Tomaga, where a chilled marginal phase of aplitic granite is developed for a short distance from the contact.

A somewhat similar aplitic granite is developed at the contact with slates near the 5-mile peg from Moruya towards Sydney. Also at Yarragee a couple of miles west of Moruya, a granitic dyke, closely related to the granodiorite mass, has intruded quartz-schists in the Council's metal quarries. About a mile and a half south-west of the town of Moruya there are several small patches of folded sedimentary rocks, which appear to have been rifted off the roof of the magma-chamber, as the fold-axes are not parallel to those uniformly developed in the adjacent sediments. No assimilation of these sediments has been observed in the granodiorite.

East of Moruya, there are other examples of included sediments, the largest of which was probably not detached, but formed a "roof-pendant" as defined by Daly (1914, p. 100). It occurs in portions 121 and 122, Parish of Moruya, and consists of meridionally folded, banded quartzites and slates, with interbedded tuffaceous and other volcanic material. The junction with granodiorite is sharply defined in many places, and there appears to be no trace of assimilation.

Elsewhere, the actual junction between the igneous rock and the altered sediments is obscured by weathering products, but the mass cuts across the bedding planes of the associated slates and schists, apparently without affecting their direction of strike.

Numerous small inclusions of country rock in the granodiorite, and the slight, though marked, parallel banding it exhibits parallel to the main trend of its outcrop, and the well-marked zone of contact metamorphism are considered to be further evidences of its intrusive nature.

No vertical cross-sections of the intrusion are available, but from a study of the detailed map of the district, and the foregoing description, it is obvious that the intrusion is portion of a batholith, which is elongated in a north-north-westerly direction and which has cut across the planes of bedding and schistosity of the country rock. These features are shown by Daly (1914, p. 95) to be characteristic of batholiths, although there may be some doubt as to whether the longer axis of the batholith is, in this case, "parallel to the tectonic axis of the mountain-built zone in which the mass is situated". It is at least interesting to note that the main trend of the Moruya River from Merricumbene to Larry's Crossing, where the river has entrenched itself to a depth of several hundreds of feet in the slate series, is in a direction approximately parallel to the elongation of the batholith, evidently following a line of weakness in this direction, possibly along a Palaeozoic fault-zone. The deflection of the river course to a southerly direction for four miles below Larry's Crossing is due to the outcrop of a hard bar of quartz-felspar-porphyry, as shown on the general map of the district.

Dr. H. I. Jensen (1908, p. 306) has noted faulting, through Devonian rocks in the Ettrema gorges near Sassafras, where Rolfe's "creek follows . . . . an old fault running N.N.W. to S.S.E. and antedating the deposition of Permo-Carboniferous strata".

This area lies to the north of Moruya, where the slates are overlain by Permo-Carboniferous strata, except where they are exposed by stream erosion.

(*c*). *History of the Intrusion.*

Summarizing the events which have taken place in the igneous history, it is evident that there was first an intrusion of basic rocks, hornblende-gabbro and diorite-gabbro, along a zone of weakness in a north-north-westerly direction through folded early Palaeozoic sediments. This intrusion was followed by an injection of tonalite and granodiorite, and later by biotite-granite, each of which has its own peculiar and characteristic composition, yet shows indubitable evidence of consanguinity with the other types, the whole series occurring as a plutonic complex in the form of a composite batholith.

The cooling and contraction of the plutonic rocks allowed the formation of veins and dykes of aplite from the residual magma, and at a later period, dykes of intermediate and more basic composition, the hornblende-quartz-porphyrites and basaltic types, were injected along fissures generally parallel to the system of joints, which are transverse to the batholithic axis.

The metalliferous deposits in the neighbourhood of Condoin Creek, south-west of Moruya, probably represent the closing phase of this igneous activity.

Thus all the evidence available, the field relations and the mineralogical and chemical evidence, points to the fact that magmatic differentiation of a serial nature has been effected by some means in the original magma-reservoir.

It seems that the differentiation has not taken place in the position in which the rocks now occur, for there are definite intrusive relations between the gabbro and the tonalite, and there is not a gradual transition in the composition of the three main plutonic types, gabbro, tonalite-granodiorite, and biotite-granite.

With the exception of dyke rocks, the "basic segregations" are the only rocks which are intermediate in composition between these main types, and it has been shown that they are really cognate xenoliths. Further, the disposition of the outcrops of the chief rock-types does not indicate differentiation in place. If separation into basic and acid fractions of the magma had occurred, it might be expected that the basic portion would occupy the lower part of the magma-chamber, yet actually the gabbros occur at higher altitudes than the more acid types, although there is no evidence in the surrounding invaded sediments that any tilting movement has taken place in the district.

The occurrence of granite at Conjola, seventy miles north and also near Bodalla, fifteen miles south of Moruya, apparently identical with the biotite-granite north-west of Moruya, suggests a common source of origin in an inter-crustal reservoir. It is considered that the batholith at Moruya is but one expression of Palaeozoic igneous activity in the South Coast district, and that the complete history will not be known until the other granitic and monzonitic intrusions of the South Coast have been studied.

Attention has already been called to the similarity of the chemical nature of the series at Moruya and at Garabal Hill, and closer investigation reveals other resemblances. The series at Garabal Hill was used by Harker (1909) as an example of a typical subalkaline plutonic complex, and later Bowen (1922, p. 189) used it to illustrate the reaction principle in petrogenesis.

At Moruya, as well as at Garabal Hill, the order of intrusion is that of decreasing basicity and increasing alkalinity, which is considered by Brögger (1895) to be the normal order of intrusion. Also, there are parallel orders of appearance and disappearance of the constituent minerals in both series, which, according to Bowen, "is the very essence of the reaction series" as opposed to eutectic crystallization. Nevertheless, both series are really discontinuous in that they contain two gaps, one between the basic and intermediate types and one between

the intermediate and acid plutonic rocks, thus presenting certain difficulties in the explanation of the differentiation. These difficulties led Wyllie and Scott to postulate a separate origin of the ultrabasic and acid magmas at Garabal Hill.

At Moruya, the obvious genetic relationships of the exposed rocks do not seem to be in accordance with this idea, and the most probable explanation of the rock association appears to be that differentiation of an originally homogeneous magma took place in an intercrustal reservoir by means of fractional crystallization and the sinking of crystals, similar to that postulated by Bowen (1915-1919). Orogenic earth movements took place when the liquid portion of the magma had reached about the composition of the diorite-gabbro, and portion of this magma was injected along the zone of weakness in the upper layers of the earth's crust, now occupied by the Moruya batholith. This portion of the magma crystallized as the diorite-gabbro.

Meanwhile, crystallization-differentiation of the remaining liquid was proceeding quietly in the main magma chamber, the liquid becoming progressively more acid as the minerals of early crystallization were formed. Further earth movements caused relief of pressure and allowed of the injection of a portion of the remaining liquid magma, possessing at this time a composition about that of the tonalite and granodiorite. As a relatively large portion of this was injected, it is possible that some local differentiation took place during its consolidation, or the injected magma may have been already partly differentiated, thus producing the variation from tonalite to granodiorite.

Further differentiation of the magma in the main reservoir produced a liquid still more acid than the granodiorite, and later movement allowed of its intrusion into the position now occupied by the biotite-granite.

It seems feasible that the masses of hornblende-gabbro and the quartz-mica-diorite xenoliths, both of which are more basic than their hosts, the diorite-gabbro and granodiorite respectively, were fragments of more or less consolidated portions of the original magma, which were carried up and included in the injected magmas.

The true segregation veins and patches in the diorite-gabbro are undoubtedly the final products of consolidation of the magma in place, and probably many of the aplite veins and dykes have been formed in a similar manner from the granodiorite; the origin of the later porphyrite and basaltic dykes is more obscure, and no satisfactory explanation is offered for their occurrence.

This interpretation of the plutonic differentiation seems to be in accordance with the main facts, explaining as it does (i) that the chief types are members of a continuous series produced by serial differentiation, and that they are really evidences of the composition of the liquid part of the magma at certain stages in its history; (ii) the normal order of decreasing basicity in the intrusion of the main types; (iii) the relatively uniform composition of the individual types, which were injected during short periods of diastrophism; (iv) the gaps in the series, which represent periods of quiescence, when differentiation was proceeding without interruption in the intercrustal reservoir; (v) the shape of the batholith, elongated in the direction of crustal weakness; and (vi) the occurrence in neighbouring localities of granite of the same character as that in the batholith, as earth movements probably caused relief of pressure and opportunity for the injection of magma of uniform composition over a considerable area at about the same time.

(vi.) *Age of the Intrusion.*

There is no conclusive evidence in the Moruya district with regard to the age of the intrusion. The batholith intrudes rocks which are either Ordovician or

Silurian in age, and is partly covered by Tertiary beds. The faulting in a direction parallel to the longer axis of the Moruya batholith, which has been recorded by Dr. Jensen as occurring near Sassafras, probably belongs to the same orogenic period, that is, between the deposition of the Devonian sediments and the overlying Permo-Carboniferous strata.

It was considered by Anderson (1892, p. 164) that the intrusion of plutonic rocks of the South Coast, including those at Moruya, which he describes, "probably dates between the Upper Silurian and the deposition of the Devonian conglomerates, the exact position of which in the Devonian Series has not yet been worked out". No specific evidence is brought forward in support of this statement, and the Devonian age of these conglomerates is unproven.

A comparison with the granitic series in other parts of Eastern Australia may be of advantage in attempting to determine the age of the South Coast Intrusives.

In New South Wales little detailed work has been published on the granites of the State. Süssmilch (1914) has given a summary of our knowledge of these igneous rocks. Dealing with the earlier Palaeozoic intrusions he states, "Acid plutonic rocks are extensively developed over the southern and central tableland areas of N.S.W. Many of these intrude strata of Upper Devonian age and belong, therefore, to the Kanimbla Epoch: none are younger, some are probably older".

In the New England district, the plutonic complex described by Mr. Andrews, was injected in later Palaeozoic time, commencing in the Carboniferous, and continuing until Permo-Carboniferous time.

At Mt. Macedon in Victoria, there is another series, also very similar to that at Moruya, which has been described by Skeats and Summers (1912, p. 55) as a "Devonian sub-alkali province". It does not seem improbable that more detailed work on the intrusive rocks of the South Coast will show their close relationship with the Palaeozoic intrusions of Victoria, with regard both to the composition of the original magma and to the age of the intrusions.

In Queensland, the major intrusions of Palaeozoic granite, such as that at Stanthorpe, are considered to be of Permian or Permo-Carboniferous age.

The trend of evidence, therefore, is that granitic intrusions took place in Victoria during the Devonian period, the active front of invasion advancing like a wave in a northerly or north-easterly direction into New South Wales towards the close of the Devonian, and into New England in Carboniferous time, reaching Queensland during the Permian or Permo-Carboniferous period. This idea has been expressed diagrammatically by Professor Benson (1923, p. 15).

Hence, it is highly probable that the intrusion at Moruya is no exception to the general rule as stated by Mr. Süssmilch for the central and southern tablelands, and that its injection most probably took place in late Devonian time, during the Kanimbla Epoch.

(5) The Metamorphic Series.

Two periods of metamorphism have left their impress on the older sediments of the area under consideration.

The earlier period was one of regional metamorphism, which affected a large part of the central and southern tablelands and south coast of New South Wales. In this metamorphism the main factor was lateral pressure, apparently from the east, which produced meridional folding and faulting of the fine-grained argillaceous and arenaceous sediments of the Moruya district. The rocks were hardened and compacted to form slates, phyllites and quartzites, without appreciable recrystallization of the constituent minerals. Vertical meridional cleavage was developed

throughout the area, the planes of cleavage frequently cutting across the bedding planes of the folded sediments. The almost entire lack of fossil organisms throughout the series is undoubtedly due to this metamorphism, which has obliterated all traces of the finer structures likely to occur in argillaceous sediments.

By analogy with other parts of the State it seems probable that this metamorphism took place at the close of the Silurian period.

Superimposed on this metamorphism is a phase of local or contact metamorphism, the direct result of the intrusion of the composite batholith. The effect of this phase is expressed in a zone of recrystallized rocks bordering the batholith, the width of outcrop of the aureole being approximately half a mile. The batholith is transgressive, cutting across the planes of bedding and cleavage of the country rock. As far as could be ascertained, the schistosity, commonly produced by the development of flakes of mica arranged in parallel orientation, is not parallel to the bounding surface of the batholith, but is parallel to the bedding of the original sediments from which the metamorphic rocks were derived. Thus it seems that heat rather than pressure was the dominant factor in this phase of contact metamorphism.

It was not found possible to distinguish exactly the effect on the sediments of the successive injections of magma, nor was it possible to map concentric zones of metamorphism. The rocks are of the nature of schists and hornfelses and have been derived from three main types:

(i) Arenaceous sediments,
(ii) Argillaceous sediments,
(iii) Basic igneous rocks.

No calcareous rocks are known to occur in the district.

(i). Arenaceous sediments.—The purest siliceous rock of sedimentary origin occurs in the Government quarry about a quarter of a mile east of the granodiorite contact on the northern bank of the Moruya River. This rock has been used in the building of the breakwater and training wall near the mouth of the river. Somewhat similar rock occurs, in bands, through the quarry at Yarragee.

The rock is very hard, fine-grained, dark grey and traversed by narrow veins of white quartz. It consists of angular fragments of quartz, less than 0·5 mm. in diameter, set in a matrix of microcrystalline quartz, with small amounts of biotite, muscovite and iron ore, the latter material being obviously recrystallized cement.

The rock is a quartz-hornfels.

More common varieties are those which have contained argillaceous or felspathic material as a cement for the quartz grains.

These rocks outcrop in the southern portion of Tuross Peninsula, at Du Ross Head (Mullimburra Head), on the main road a mile north of Coila, and at intervals along the western boundary, as well as on the main road five miles north of Moruya. They have been completely recrystallized to form fine-grained schists, which vary in colour from buff to brown or dark grey. It is the development of tiny flakes of mica arranged in parallel orientation, which gives the rock its schistose appearance. Under the microscope, it is seen to consist chiefly of irregular grains of quartz elongated in the direction of schistosity, with occasional orthoclase and somewhat abundant reddish-brown biotite and a smaller amount of muscovite. These rocks may be described as quartz-mica-schists (Plate xviii, fig. 6).

(ii). Argillaceous sediments have produced a variety of metamorphic types, which are exposed over the greater part of the aureole, the best outcrops being along the western boundary of the intrusion. Certain bands close to the contact

have produced rocks containing the mineral cordierite, which is not developed in parts remote from the intrusion. A fresh exposure of cordierite-hornfels occurs in contact with a granitic dyke in the quarry at Yarragee, a couple of miles west of the town of Moruya. This is a dense dark blue rock, with a slightly resinous lustre. Under the microscope it shows poikiloblastic structure, the ground fabric consisting of xenoblasts of cordierite 2 mm. or more in diameter, crowded with tiny idioblasts of reddish-brown mica, muscovite and possibly quartz, producing a kind of sieve structure. A photograph of this rock appears on Plate xvii, fig. 5.

More remote from the contact are the "spotted schists"; as the contact is approached these "spots" give place to "knots" of varying dimensions, which are set in a very micaceous matrix of a dark grey to light greenish-grey colour. In places where the original bedding has been preserved, it may be seen that the "knots" attain greater development and greater abundance in some of the original layers than in others adjacent, showing that the original composition had a direct influence on their formation. The "knots" vary from a fraction of a millimetre to nearly one centimetre in length, and the habit is prismatic, suggesting that the mineral is andalusite. Under the microscope, however, no definite andalusite can be seen; the "knots" or porphyroblasts consist of fine-grained "shimmer aggregates", which once may have been either andalusite or cordierite. They sometimes contain patches of isotropic material. The ground fabric is lepidoblastic and exceedingly fine-grained.

(iii). A kind of hornblende-schist, evidently a metamorphosed igneous rock, outcrops near the headland north of Kelly's Point, known locally as "The Clear Hill". The outcrop is surrounded on the landward side by the igneous rocks of the Moruya complex. At the base of the cliff-face, the tonalite is seen to underlie this rock and to send up fine apophyses through it. From its mode of occurrence, therefore, it is impossible to determine whether it was interbedded with the older sedimentary series, or whether it was an early-formed member of the plutonic complex, which has been metamorphosed by subsequent intrusions.

(6) Tectonic History of the Area.

The older sedimentary rocks of the area are folded about axes which trend almost due north and south. Faulting and cleavage are also developed in this direction, giving the grain of the country a decided north and south trend. The intensity of the folding appears to have been greater in the east than in the west, and the faulting has been accompanied by the intrusion of massive quartz-porphyry. The dips of the faults are usually very steep, almost vertical, but occasionally (along the course of the Deua) the faults dip at low angles to the east with overthrusting from the direction of the Tasman Sea.

The intrusion of the Moruya batholith took place at a later date along a zone of weakness, probably of faulting, extending in a north-north-westerly direction. Not only do the mapped boundaries of the batholith conform with this direction, but also the internal structures of the batholith, the parallel arrangement of the minerals and inclusions, the rift and grain structures, and the directions of the joints and dykes in the granodiorite, all indicate a change in the direction of the trend lines from north and south to north-north-west and south-south-east.

The disposition of the joint and dyke systems within the batholith itself seems to agree with the ideas put forward by Cloos (1922; 1923) as interpreted by Tyrrell (1926) and Kemp (1925).

In describing the tectonic history of New South Wales in 1914, Professor David states: "In the Bathurst-Monaro Tableland the old trend lines are still shown by the direction of outcrop of the chief beds of limestone of Silurian age, which there run north and south. Towards the northern edge of the plateau these fold lines swing round more west of north, the chief synclinal troughs in the Upper Devonian series lying along directions between north-north-west and north 30° west. . . In the Yass district the general trend of the folds in Silurian and also Devonian rocks is north 15° west and south 15° east". In the New England district the "Carboniferous and Devonian rocks have been folded and powerfully fractured along this north-north-west and south-south-east tectonic zone".

This later trend at Moruya is therefore not an unusual one for New South Wales, although it is not so important as in Queensland, where, according to Bryan (1925), "This N.N.W. trend is all important in the structural geology". Elsewhere (p. 21) he states "The N.N.W. trend . . . seems everywhere to be later than the Devonian period, and may be in part Post-Carboniferous".

The effects of the older north and south trend and the newer north-north-west and south-south-east trend at Moruya are apparent in the physiography of the district, and will be discussed in a later paper.

(7) Summary.

The paper includes a geological sketch-map of the Moruya district, covering an area of about 100 square miles, with an account of the Palaeozoic geology of this area and of other places of interest within a radius of about 25 miles of Moruya.

The salient features in the Palaeozoic geology are (1) the deposition of a series of argillaceous and fine-grained arenaceous sediments during the Ordovician or the Silurian period; (2) the subsequent folding and faulting of these sediments in a meridional direction during a period of regional metamorphism, which probably dates to the close of the Silurian; (3) the alteration in the trend lines to a north-north-westerly and south-south-easterly direction, and the injection of a plutonic igneous mass along a zone of weakness in this direction, probably at the close of Devonian time.

The plutonic mass takes the form of a composite batholith, and forms a complete subalkaline or calcic igneous complex, as is proved by a study of the field-relationships, and the mineralogical and chemical compositions of the various members of the series. The complex consists of three main plutonic types, diorite-gabbro, tonalite-granodiorite and biotite-granite, containing accidental and cognate xenoliths in some parts, and a series of dyke rocks ranging from aplitic to basaltic varieties. Magmatic differentiation of a serial nature probably took place in an intercrustal reservoir by means of fractional crystallization and the sinking of crystals, the liquid portion of the magma being injected at various stages into the upper layers of the earth's crust, and producing an order of decreasing basicity and increasing alkalinity in the intrusion of the plutonic types.

Acknowledgments.

In conclusion, the writer wishes to thank those who have assisted in the preparation of this paper, especially Professor L. A. Cotton, M.A., D.Sc., in whose Department the laboratory work was carried out, Assistant-Professor W. R. Browne, D.Sc., for helpful discussion of the work, and Mr. H. G. Gooch for assistance in microphotography.

The writer also wishes to express appreciation of the kindness and hospitality shown by residents of Moruya, particularly Mr. and Mrs. H. Parbery and family of Gundary, Mr. and Mrs. J. A. Greig and family of "The Priory", Bergalia, and Mr. and Mrs. J. Greig of "Bergalia House", Bergalia, during the course of field-work in the district.

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EXPLANATION OF PLATES XV-XVIII.

Plate xv.

Geological Sketch map of the Moruya District.

Plate xvi.

1. Folded, thin-bedded quartzites, about one and a half miles south-west of Moruya. This is portion of a mass of sedimentary rocks which appears to have been rifted off the magma-chamber (see p. 184).
2. View at Kelly's Point, showing jointing of the tonalite and diorite-gabbro, and its influence on the direction of the basaltic dykes.

Plate xvii.

1. Biotite-Granite, N.W. of Moruya, showing orthoclase with microperthite. Crossed nicols. Magnified 12 diameters.
2. Granodiorite, quarry, 2 miles east of Moruya. Note fracture and granulation. Crossed nicols. Magnified 9 diameters.
3. Fine-grained Granodiorite, 1 mile S.W. of Moruya, showing rounded grains of quartz included in outer zones of plagioclase phenocrysts. Crossed nicols. Magnified 12 diameters.
4. Basic Inclusion in Granodiorite, showing large plate of biotite with inclusions of felspar. Ordinary light. Magnified 9 diameters.
5. Gabbro, north of Kelly's Point, showing large crystal of brown hornblende containing remnants of original augite; border consists of green hornblende. Crossed nicols. Magnified 13 diameters.
6. Typical Gabbro, Kelly's Point, showing brown hornblende (dark) bordered by green hornblende (lighter); Plagioclase appears white. Ordinary light. Magnified 9 diameters.

Plate xviii.

1. Plagioclase in graphic intergrowth with augite, hornblende and iron-ore, in Diorite-gabbro, Kelly's Point. Crossed nicols. Magnified 9 diameters.
2. Portion of the above Plagioclase showing details of graphic intergrowth. Crossed nicols. Magnified 14 diameters.
3. Hornblende-quartz-Porphyrite, Dyke, Tuross, showing granophyric structure in the groundmass. Crossed nicols. Magnified 16 diameters.
4. Mica-Lamprophyre, Lake Coila. Ordinary light. Magnified 12 diameters.
5. Cordierite-Hornfels, Yarragee. Crossed nicols. Magnified 13 diameters.
6. Quartz-mica-Schist, Yarragee. Crossed nicols. Magnified 13 diameters.

THE LARVA OF *HEMIPHLEBIA MIRABILIS* SELYS (ODONATA).

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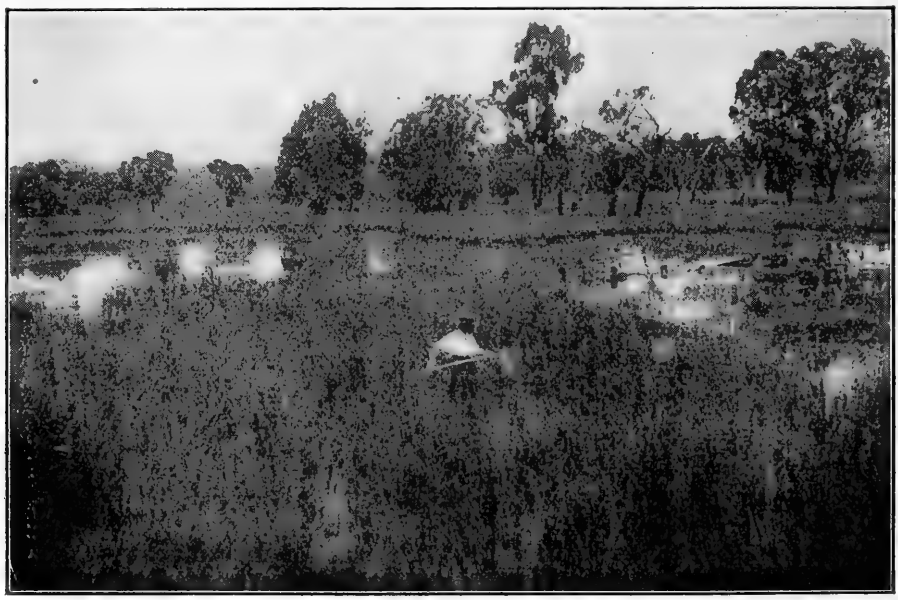
(Thirteen Text-figures.)

[Read 30th May, 1928.]

Hemiphlebia mirabilis Selys is a tiny metallic green damselfly of very great morphological and phylogenetic interest. It is entirely confined to Australia, the only known localities for it so far being Port Denison (Bowen) in Queensland (the type locality), and Alexandra, Victoria. It is one of the smallest of living dragonflies, its expanse of wing being only three-quarters of an inch or a little more. De Selys (1877) placed it at the very end of his group or "legion" *Agrion* of the subfamily Agrioninae, next to the genus *Agriocnemis*; in more modern classification, this would put it at the end of the family Coenagriidae. In 1913 (p. 463) I described the appendages of the male and recorded the peculiar mode of courtship of these tiny insects amongst the reed-masses of the backwaters of the Goulburn River at Alexandra, where I studied the insect in December, 1906. Later, I sent specimens to Professor C. H. Kennedy at Columbus, Ohio, for the study of the penis of the male. He came to the startling conclusion that this little insect had one of the most generalized forms of penis known within the Order Odonata (Kennedy, 1920). Later still, the discovery of ancient forms of Zygopterous dragonflies in the Lower and Upper Permian (Tillyard, 1925, 1926*a*, 1928) indicated a very close relationship between the original ancestral type of the whole Order Odonata and this Australian genus, while a detailed comparison of the wing-venations made it quite clear that *Hemiphlebia* stood quite isolated amongst existing forms and must be regarded as the sole representative of a distinct family Hemiphlebiidae (Kennedy, 1920; Tillyard, 1926*b*) standing at the very base of the Zygoptera.

It will thus be seen that the progress of researches on the Order Odonata, in the course of the last twenty years, has picked out this obscure Australian genus from a mass of unrelated forms and set it up as one of the key-genera for the right understanding of Odonate phylogeny. As soon as this had been done, it at once became of the utmost interest that the larva should be discovered and studied also, in order that we might see what evidence was available from such important larval characters as the wing-tracheation, the labial mask, the mandibles, the gizzard and the caudal gills. The opportunity to do this presented itself when the Commonwealth Government recently invited me to visit Australia in connection with the organization of entomological research. Arrangements were made to spend a long week-end at Alexandra some time in November. Through the kindness of Mr. Michael Martin, Manager of Sulphates Proprietary Ltd., of 395, Collins Street, Melbourne, and Mr. C. R. Lyne, of Hartley's Proprietary, Ltd., 270, Flinders Street, Melbourne, a private car was placed at my disposal, and a party was

formed of these two gentlemen, both of whom are keenly interested in trout-fishing, Mr. G. F. Hill, F.E.S., Entomologist to the Commonwealth Council for Scientific and Industrial Research, Mr. J. Clark, Entomologist to the National Museum, Melbourne, and myself. We drove out to Alexandra, a distance of close on one hundred miles from Melbourne, on Saturday, 5th November last, and worked the Goulburn River the same evening and on the Sunday and Monday following. I wish here to express to all these gentlemen my very sincere thanks for the assistance given me in this undertaking. I also wish to thank Mr. A. L. Tonnoir for assistance in the preparation of slides and for the drawing of Text-fig. 8; and Mr. W. C. Davies for enlarging the photograph reproduced in Text-fig. A.



Text-fig. A.—Backwater of the Goulburn River, near Alexandra, Vic., showing reed-beds in foreground, where larvae of *Hemiphlebia mirabilis* Sel. were found. Mr. J. Clark, F.E.S., with dredging-net.

[Photo. by R. J. Tillyard.

My previous visit to Alexandra was in December, 1906, or nearly twenty-one years earlier. Owing to the long period of time that had elapsed, my memory of the intricate backwaters of the Goulburn River was not sufficiently clear for us to locate, at the first attempt, the exact place where the tiny insect had been found before. As the dragonflies themselves had been taken on the wing on 22nd and 23rd December, we did not expect to find any of them about early in November, but we hoped to discover the full-fed larvae. About two hours were spent on the Saturday evening searching for the original locality, but without success. On the Sunday morning the search was continued, and I extended my survey of the backwaters to a distance of well over a mile above the bridge before I suddenly came upon the very clumps of reeds where I had first seen the tiny insects executing their delightful mating dances. We discovered later that

there was a good reason why the insect was confined to this small area; for, during the periodical droughts that occur, all the rest of the huge backwaters dry up; but, just at this point (Text-fig. A) there is a rather deep hole between the clumps of reeds, and this serves as a reservoir for the larvae when no other water is available.

The position having been located, all five of us got to work with nets, scoops and sharp knives. The reeds were cut off in clumps, close to their roots; the water-weeds were dredged up in masses; the bottom mud was scooped up and examined; in fact, everything was done to ensure that the larvae should not escape us. Preliminary exploration of the rest of the backwater had yielded only a few common types of damselfly larvae, viz. *Austrolestes analis* Ramb., *A. leda* Sel., *Ischnura heterosticta* Burm. and *Austroagrion cyane* Sel. I was looking for a damselfly larva of a type unknown to me, since that would almost certainly prove to be *Hemiphlebia*. We worked for well over an hour before I noticed a small, dark brown, sluggish larva separate itself from a tangled mass of reed-stems and water-weed. An examination of this larva showed that it was of a type new to me, so we decided to continue searching for more, and to take them back alive to the hotel at Alexandra, where I had the necessary microscopes and dissecting instruments ready. At the end of three hours' work we had about two dozen, most of which had been found clinging closely to the lower portions of the stems of the weed *Myriophyllum*, while a few were found clinging to the bases of the stems of reeds and submerged grasses. The lower leaves of *Myriophyllum* are of a dirty brownish colour, and the larvae were practically invisible in such a position until they moved.

During the same afternoon, I dissected and studied four of these larvae and was soon able to determine them definitely as larvae of *Hemiphlebia*. The first diagnostic character used was the absence of the basal cross-vein closing the quadrilateral in the forewing; this was very clearly shown in all well-grown larvae. The only other dragonfly at present existing which possesses this character is *Chorismagrion risi* Morton from North Queensland; this is about four times as large as *Hemiphlebia mirabilis*. Apart from this, it soon became evident that the larvae possessed a number of other unique and unexpected characters which rendered it even more important from the viewpoint of phylogeny than I had imagined it would be.

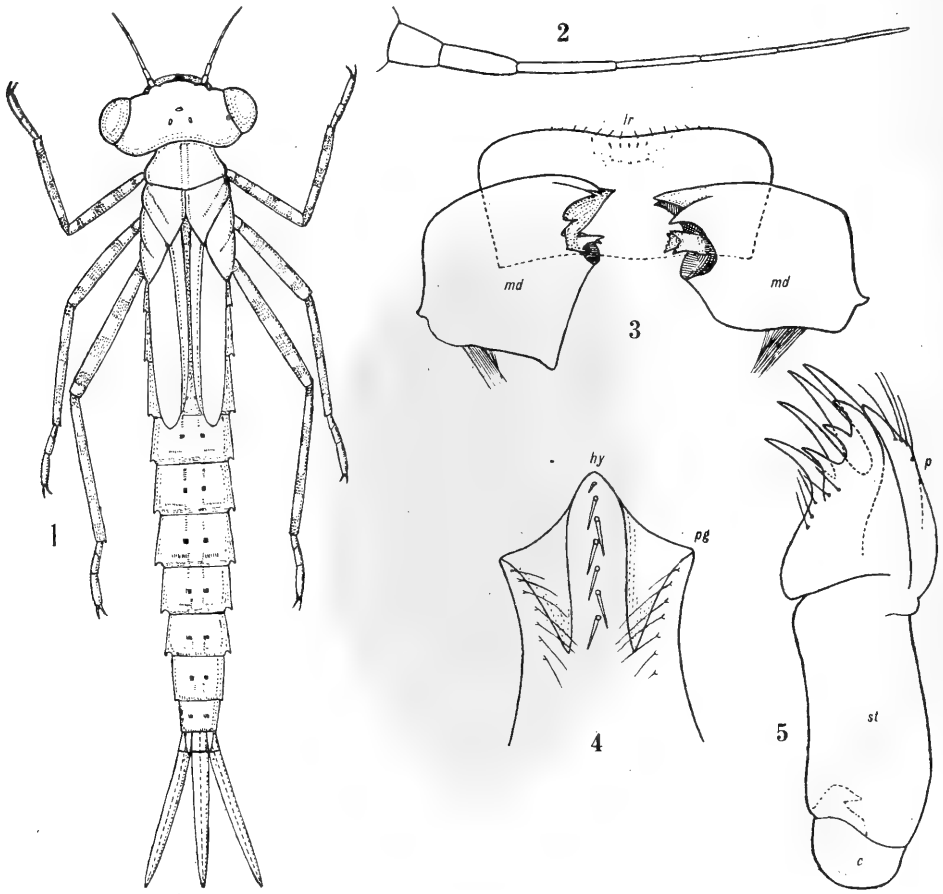
Accompanied by Messrs. Lyne and Clark, I again visited the locality on the Monday morning, our captures for about two hours' work amounting to twenty-six, all found within a few yards of the original reed-clumps where I had first taken the dragonfly. Thus we returned from Alexandra with fifty of these larvae, some alive and some carefully preserved in Blé's solution. All of these were in the last instar, and some must have been within a week of emergence, judging by the clear formation of the imaginal antennae and tarsal claws inside the larval organs.

Description of the Larva. Text-figs. 1-12.

Total length including caudal gills (average), 13·5 mm.; length of abdomen, 7·5 mm.; breadth across head, 2·5 mm., across sixth abdominal segment, 1·5 mm.; length of wing sheath, 3·1 mm., of antenna, 1·4 mm., of caudal gills (lateral), 2·5 mm.; of paraprocts (cercoids), 0·5 mm.; lengths of femur, tibia and tarsus respectively: fore leg, 1·5, 1·6, 1·0 mm.; middle leg, 1·8, 2·0, 1·2 mm.; hind leg, 2·5, 2·5, 1·3 mm., the tarsal measurements including the claws.

General colouration a dull, medium or dark brownish, with very little pattern except on the legs, which are banded with darker brown as shown in Text-fig. 1.

Head more than twice as wide as long, only slightly concave posteriorly between the moderately prominent postocular lobes, which are rounded. Compound eyes prominent, dark brown, button-like; ocelli distinct, dark brown; antennae



Text-figs. 1-5.—*Hemiphlebia mirabilis* Sel.
1. Full-grown larva. Length, including gills, 13·5 mm. 2. Antenna of full-grown larva. Length 1·4 mm. 3. Labrum (*lr*) and mandibles (*md*) of full-grown larva (× 50). 4. Hypopharynx (*hy*) and paragnaths (*pg*) of full-grown larva (× 75). 5. First maxilla of full-grown larva (× 75). *c*, cardo; *p*, palpus; *st*, stipes.

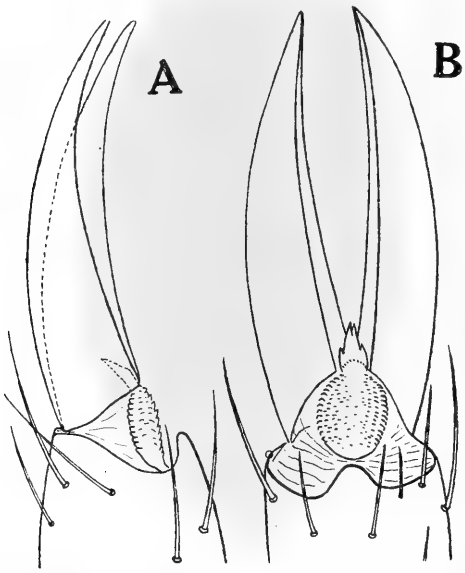
smooth, hairless, rather long, 1·4 mm., consisting of seven segments, of which the first or scape is somewhat swollen, subconical, half as long again as wide, the second or pedicel longer and less swollen, about three times as long as wide, and the other five, or distalia, are elongated and very slender (Text-fig. 2); ratios of the lengths of the segments from base to apex, 14 : 20 : 26 : 22 : 20 : 18 : 17. Labrum (Text-fig. 3) more than twice as wide as deep; margin well rounded

laterally, slightly emarginate medially, with a few short, weak setae on the median portion and a few small, scattered sensillae just above them around the median line on the epipharynx. Mandibles (Text-fig. 3) very stout and strong, markedly asymmetrical, of primitive type, showing clearly differentiated incisor and molar areas on the inner or cutting surface; the right mandible has three strong teeth placed close together near the apex of the incisor area, with a smaller one on the inner margin well removed towards the molar portion; the latter carries a strongly projecting bifid prong; the left mandible has three strong incisor teeth, two at the apex and one somewhat removed and turned curvingly inwards, while the molar area carries a much larger projection than that of the corresponding area of the right mandible; this projection has a broad, hollowed out apex, split open on the inner side, and bordered elsewhere by six irregular teeth, four fairly large and two very small. It would appear that the prong of the right mandible works into the hollow of the larger process on

Text-figs. 6, 7.—*Hemiphlebia mirabilis* Sel.
6. Labial mask of full-grown larva (× 45). *ll*, lateral lobe; *mh*, movable hook; *ml*, median lobe; *mt*, mentum. 7. Lateral lobe of same (× 140). *mh*, movable hook; *s*, seta of same.

the left mandible, while the incisor teeth of one side fit more or less accurately into the clefts between those of the other. Hypopharynx (Text-fig. 4) remarkably well developed, with prominent median tongue and strongly projecting side-lobes or paragnaths; the former carries a median row of strong setae directed inwards, while the latter each bear a row of about seven long, slender hairs. Maxillae (Text-fig. 5) with short cardo, elongate stipes, and well developed inner lobe carrying two sets of teeth, the outer four in number, long and rather slender, the inner three in number, shorter and broader; the former may represent the marginal armature of the galea, the latter that of the lacinia; a few stiff hairs situated just basally from the teeth; palp short, its tooth-like apex projecting not quite as far distad as the first lacinial tooth, its outer margin at about one-third from apex slightly humped and carrying four slender, long hairs. Labial

mask (Text-figs. 6, 7) very long and slender, 3 mm. when fully extended, with long, narrow submentum, strong hinge, mentum narrow basally but expanding widely distally; median lobe with slight indication of separation from mentum proper, and consisting of a pair of broad, flat lobes with crenulate outer margins, separated by a very deep, narrow cleft, and a pair of well separated, prong-like processes of large size, nearly as large as the movable hooks of the lateral lobes, but curved in the opposite direction; there is a stiff seta close to the base of each prong, on the side removed from the middle line. Lateral lobes of complex structure; movable hook large and strong, with a single seta projecting inwards at right angles and situated very close to the base of the hook; no other setae present on lateral lobes at all; distal margin carrying a strong tooth similar to, and nearly as large as the movable hook, and a much shorter, irregularly denticulate process; apex of lateral lobe projecting as a strong, slightly nodding tooth, with its free inner margin convexly curved and very slightly crenulate. Text-fig. 7 shows all these structures enlarged.



Text-fig. 8.—*Hemiphlebia mirabilis* Sel. Tarsal claws of full-grown larva (× 220). A, lateral, B, ventral view. (*Drawn by A. L. Tonnoir.*)

Thorax: Prothorax about half as wide as head posteriorly, but considerably narrowed anteriorly; smooth, without tubercles. Pterothorax (= meso- plus metathorax) also smooth, without hairs or tubercles of any kind; spiracles of mesothorax clearly marked, those of metathorax indistinct; wing-sheaths projecting backwards subparallel to one another for a distance of about 3 mm., the apices of the hind wing-sheaths just overlapping the distal margin of the third abdominal segment. Wing-venation very strongly indicated, pale creamy on a dark brown wing-sheath. Wing-tracheation described separately below (p. 201).

Legs rather long, pale semi-transparent brownish with darker banding on the femora and tibiae, as shown in Text-fig. 1; tarsal claws without an internal tooth, but with a small, curiously formed, retractile pad or arolium projecting

between their bases (Text-fig. 8); this pad is in the form of a broadly oval area of rugose chitin situated in the middle of the soft membrane at the bases of the claws, and having a peculiar toothed projection distally; when the claws are retracted, the whole of the pad folds in between the claws and the tarsus, and is protected externally by a marked mid-ventral process from the end of the last segment of the latter.

Abdomen subcylindrical, somewhat flattened ventrally, the first six segments very nearly of equal width, the rest tapering towards the anal end, the tenth segment being little more than half the width of the seventh; first segment short, second to eighth segments each about two-thirds as long as wide; first eight segments slightly narrower basally than distally, the distal border ending posteriorly on each side in a small, backwardly projecting spine. Colour-pattern indistinct, the chief markings being a pair of dark brown spots not very close together near the mid-dorsal surface of each segment; segment 10 also has two less distinct spots placed dorsolaterally; there is also a slight indication of a somewhat paler mid-longitudinal line and a darkening of the posterior margin of each segment. Paraprocts (cercoids) clearly visible, 0·5 mm. long, pointed. Caudal gills (Text-fig. 9) held in the living insect not very wide apart, the median gill only slightly raised, the laterals slightly lowered and only moderately diverging; lateral gills 2·0 to 2·6 mm., the median very slightly shorter and broader. Each lateral gill is a rather broad vertical lamella, suboval in shape, broadest at about two-thirds from base, and almost completely rounded at its apex, except for a very small and obtuse apical angle; the upper edge of the lamella is fringed with abundant soft hairs, very short along the basal half, but becoming longer and more conspicuous distally up to within a very short distance of the apex, and interspersed here and there with short spines; the lower edge is armed with a series of closely set, short spines or setae directed forward and outward, and mostly separated by delicate but slightly longer hairs; the midrib is slightly curved towards the lower edge and considerably nearer to it than to the upper; it is armed on the outer side only by a series of about twenty to twenty-five short but stout spines, with rudiments of one or two more close to the base. The median gill (Text-fig. 9) is slightly broader and more symmetrical in shape, with its midrib straighter, and armed, near the base, on both sides, with eight to ten short, stout spines of the type seen in the lateral gills; the upper edge is armed similarly to the lower edge of the lateral gill, and *vice versa*. The tracheal supply closely resembles that of the gills of the genus *Synlestes* (Tillyard, 1917, p. 193, fig. 84A), the main tracheal trunks being stout and following the midrib, while the branch tracheae come off obliquely and branch very little. The colour of the gills is semi-transparent brown, sometimes with considerable development of deep rose-pink or purple bordering the midrib, and slighter indication of darker patches of pigment irregularly placed elsewhere. The breaking joint of each gill is very strongly marked, situated nearly 0·5 mm. from the gill-base (Text-fig. 9, *bj*); the two main longitudinal tracheae are quite large where they pass the joint, but the gills become detached very easily and apparently without any damage to the larva, as one finds quite a number of them without their gills.

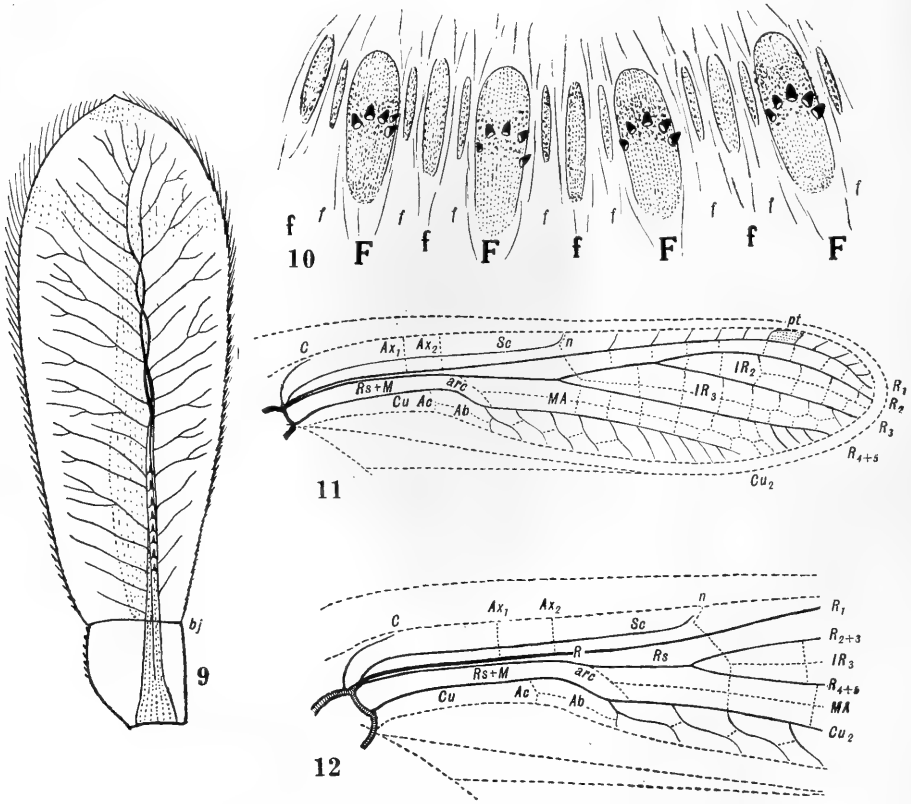
Rectal breathing takes place, but apparently very sluggishly. When opened, the rectum is seen to contain three large longitudinal folds, one dorsal and two latero-ventral, separated by three very small folds, two latero-dorsal and one ventral. These folds receive a special tracheal supply but only a poorly developed

one; they are evidently rudimentary rectal gills of the type found in other Zygopterous larvae (see Calvert, 1915, pp. 387-8).

Gizzard (Text-fig. 10) unique in consisting of three very distinct types of chitinous folds, as follows:—

(*a*) Major folds, denoted by **F**, which are broad, oval cushions, four in number, each covered with fine denticulations and also carrying five very large teeth, arranged in a transverse arch, as in the family Lestidae. The average length of each major fold is 0·37 mm., greatest breadth 0·12 mm.

(*b*) Medium folds, denoted by **f**, which are much narrower cushions, four in number, covered with fine denticulations only. Average length, 0·25 mm., greatest breadth 0·05 mm.



Text-figs. 9-12.—*Hemiphlebia mirabilis* Sel.

9. Median caudal gill of full-grown larva, showing breaking-joint (*bj*). Length 2·5 mm. 10. Gizzard of full-grown larva (× 56), opened by a longitudinal cut. **F**, major fold; **f**, medium fold; *f*, minor fold. 11. Last larval instar, sheath of forewing (× 27). 12. Basal portion of forewing sheath from another specimen, more greatly enlarged (× 36). *Ab*, anal bridge; *Ac*, anal crossing; *arc*, arculus; Ax_1, Ax_2, the two antenodals; *C*, costal trachea; *Cu*, cubital trachea; IR_2, IR_3, convex veins interpolated between concave branches of radial sector; *MA*, anterior median vein; *n*, nodus; *pt*, pterostigma; *R*, radial trachea; R_1, its main branch; *Rs*, radial sector trachea, with its branch tracheae R_2, R_3 and R_{4+5}; *Rs* + *M*, trachea supplying *Rs* (and *MA* in other Odonata); *Sc*, subcostal trachea.

(*c*) Minor folds, denoted by *f*, which are even shorter and very much narrower chitinous areas, eight in number, covered with fine denticulations only. Average length 0·18 mm., greatest breadth 0·02 mm.

The four major folds alternate with the four medium folds, and these eight are again separated by the eight minor folds which alternate with them. The gizzard is thus seen to consist of sixteen folds, only four of which carry large teeth. Using Higgins' Notation, the formula for the gizzard is 4 (**F**, 5 — *f*, 0 — **f**, 0 — *f*, 0).

This is the only known Odonate gizzard having three types of chitinous folds, and appears to be a survival of the primitive type from which all the others can be derived. The eight-fold Lestid gizzard has clearly evolved from it by suppression of the eight minor folds, the medium folds of *Hemiphlebia* becoming the so-called "minor folds" of Lestidae. The more normal sixteen-fold Zygopterous gizzard has arisen by the equalling-up of the four medium and four major folds, while the minor folds of *Hemiphlebia* have remained the minor folds of other Zygoptera. The eight-fold gizzard of Petaluridae must have arisen by suppression of the eight minor folds and equalling-up of the remainder, while the four-fold gizzards of other Anisoptera have evolved by suppression of all except the four major folds in *Hemiphlebia*.

Habitat.—Backwaters of the Goulburn River, Alexandra, Victoria; 6th and 7th November, 1927.

Description of the Larval Wing-tracheation. Text-figs. 11, 12.

Altogether, six larvae were dissected and studied for their wing-tracheation, viz. four at Alexandra on 6th November, and two more from those brought back alive to Melbourne, on 8th November, 1927. All six gave almost exactly the same results, the only differences being individual ones of quite minor value, such as slight variation in the number and position of certain cross-veins. The results obtained are so striking that I should have little hesitation in claiming family rank for the genus *Hemiphlebia* on them alone.

Taking first of all the basal tracheal trunk, we notice two peculiarities not found in other Odonate larval wings, viz. that tracheae Sc, R and Rs + M (this latter being the trachea called M by Needham) all come off by a short, stout, common stalk, and that there is absolutely no sign of an anal trachea, Cu coming off by itself at a point well removed from the subcosto-radial group. In all other Odonate larval wings so far studied, Sc, R and Rs + M come off separately from the basal trunk, though R and Rs + M are always very close together; also trachea A arises somewhat posteriad from Cu, approaches it closely for a short distance, and then either ends or diverges from Cu again by way of the anal crossing, Ac.

But the most striking feature about the tracheation is the complete absence of any tracheae along the courses of the convex veins, IR_2, IR_3 and MA, which are just those veins which I have claimed, on palaeontological grounds alone, to have been interpolated or added to an originally simpler venational type, such as can be found in the Palaeodictyoptera and Megasecoptera. In all other Odonate larvae, tracheae are present for IR_3 and MA, but not for IR_2 (M_{1A} of Needham). The tracheal supply of IR_3 (Rs of Needham) varies in different groups. Most of the Zygoptera have the trachea corresponding entirely with the vein IR_3. But the Lestidae have the tracheal supply of vein IR_3 developed from the anterior vein R_3, close to its origin, via the oblique vein, leaving the basal portion of

vein IR_3 without tracheal supply (the "long bridge"). In the Anisoptera, an even more complex method of supply is developed by means of a trachea descending from R at the subnodus, crossing R_2 and R_3, entering IR_3 by the oblique vein, and leaving the short basal portion, or "bridge", unsupplied by any trachea.

One consequence of the absence of the tracheae mentioned above is that there does not appear to be, in the larva of *Hemiphlebia*, any trachea which can rightly be designated as belonging to the media; for the posterior media, MP, is absent, and the anterior MA, has no tracheal supply. While, therefore, retaining the notation Rs + M for the basal trachea below R, since it supplies both Rs and MA in all Odonate larvae other than *Hemiphlebia*, it is necessary to point out that the available evidence is quite compatible with the hypothesis that this trachea may be merely Rs, and that trachea M may have disappeared with vein MP before the interpolated vein MA received any tracheal supply. This would account for the condition found in *Hemiphlebia* larvae better than any other hypothesis.

Another interesting condition of the tracheation is the series of descending branchlets of trachea Cu_2. The first of these arises just before the distal angle of the quadrilateral, and divides into a short basal and longer distal branch; from the short basal branch, a pigment band (the anal bridge, Ab) runs back to the anal crossing, Ac, which is also without any trachea. The second, third, fourth and fifth branchlets are simple, but somewhat curved; these and the distal branch of the first are connected by oblique pigment-bands representing specialized cross-veins in the imaginal wing, which help to make up the distal portion of the composite vein 1A. The more distal branchlets are shorter and straighter descending tracheae corresponding exactly with the distal branch veinlets in the imaginal wing. A series of similar short branchlets, four in number, is to be found descending from the distal end of R_{4+5}. There are no tracheae preceding the two antenodals, but all the postnodals (five in number), the two veins forming the basal and distal sides of the pterostigma, and the veins in the space beyond the pterostigma, are preceded in the larval wing by delicate tracheae. R_3 has a single, short, branch trachea near its apex, R_2 none. Sc is simple, the end of its trachea turning upwards to the costa at the nodus; the subnodus has no trachea at all, but its pigment band descends exactly on to the origin of IR_3 (Rs of Needham).

The open discoidal cell or quadrilateral of the forewing of *Hemiphlebia* is well shown in the larval wing, and is there seen to be of exceedingly simple formation. The trachea Rs + M diverges but slightly from trachea R_1, while trachea Cu_2 runs subparallel to it below, and very slightly approaching it up to the level of the second antenodal, Ax_2. About this point, Cu_2 takes a marked curve of flattened sigmoid form, thus nearly doubling its perpendicular distance from Rs + M by the time its first descending branchlet is given off. The two main tracheae, Rs + M above and Cu_2 below, are here connected by a strong pigment band representing an obliquely placed crossvein, which forms the distal side of the quadrilateral in the imaginal wing, and from the middle of which the pigment band of vein MA arises. The very obvious resemblance between this formation and those at the proximal ends of the other interpolated veins, IR_2 and IR_3, and also the formation at the meeting of Ac and Ab, must not be lost sight of.

The entire absence of trachea 1A might seem puzzling at first to those chiefly acquainted with the tracheation of Anisopterous larval wings. In Zygopterous larvae, however, this trachea is always exceedingly weak, and quite frequently

does not reach as far as Ac, as is well shown by Dr. Ris' excellent photographs of *Agrion* (*Calopteryx*) *splendens* (Tillyard, 1915, Pl. xxxiv) and by my own photographs and drawings of *Diphlebia lestoides* (1915, p. 217, Text-fig. 3, and Pl. xxxii).

General Discussion of Larval Characters.

It will be clear, I think, from the above description of the larval characters that we have to deal with a very archaic type. This conclusion is not based upon the form of any single organ, and might quite well be arrived at independently of the wing-tracheation. In order to exhibit the generalized relationships indicated by a study of the larval characters, these latter are now considered in groups according as they are unique for the Order, or show affinities with those of other families or groups of Odonata:—

(1) *Characters unique within the Order Odonata..*

(*a*). *The trifid hypopharynx.*—The most primitive groups of Insects have this character well marked, the hypopharynx consisting of a median tongue with two supporting lateral paragnaths, sometimes called "maxillulae". This type is well seen in Machilidae and also throughout the Order Plectoptera. The trifid form seen in *Hemiphlebia* larva is not unlike the stage found in the imago of most Neuroptera.

(*b*). *The presence of both glossae and paraglossae in the labial mask.*—No mask with both processes fully developed has hitherto been found in the Odonata, but a pair of minute teeth on the median lobe in a few archaic genera (e.g. *Cora*, Calvert, 1911, p. 53, fig. 28) has been interpreted as probably indicating the vestiges of the glossae. The presence of the large prongs in *Hemiphlebia* larva shows that this interpretation may possibly be correct; at the same time, the condition in *Hemiphlebia* must be regarded as very much more primitive than anything else at present known within the Order.

In view of the form of the median lobe in larvae of Plectoptera, it might be preferable to maintain that the broad lobes separated by the narrow cleft were actually the glossae, while the prongs were the paraglossae. This interpretation has the advantage of deriving the median cleft (admittedly an archaic character in Odonata) without change from an ancestor shared in common with Mayflies and other archaic insects, all of which possess such a cleft. If it be accepted, then the vestigial teeth mentioned above must be regarded as remnants of the paraglossae.

But, whichever interpretation we may adopt, it is clear that the median lobe of the labial mask in *Hemiphlebia* is unique in possessing both pairs of gnathobases well developed, as in the most primitive insects.

(*c*). *The incomplete wing-tracheation.*—The absence of tracheae for veins IR_3 and MA is unique within the Order. Vein IR_2 is never preceded by a trachea in any Odonate; hence it has never been considered a true branch of a main vein, though the fossil record shows that it has just as much claim to that status as IR_3 or MA. Most Odonata have a delicate anal trachea; but, as already pointed out, it is very feebly developed in many Zygoptera and its capture of the descending veinlet Ac appears to have been a secondary development.

(*d*). *The origin of tracheae* Sc, R_1 *and* Rs + M *from a short common stalk.*—The nearest parallel to this is to be found within the Order Plectoptera, where the subcosto-radial group of tracheae usually arises from a single long stalk, though sometimes from two tracheae arising very close together; (M sometimes arises from this same stalk, sometimes separately from the basal trunk).

The general indication given by the above unique archaic characters is for a somewhat distant relationship with the Plectoptera.

(2) *Characters shared with the Synlestidae.*

(*a*). *The form of the caudal gills.*—These are so close to those of the genus *Synlestes*, particularly to *S. albicauda* Till., that on this character alone one would classify *Hemiphlebia* as a member of the family Synlestidae. The shortness of the gills, their general shape, the oblique position of the branch tracheae, the armature, pigmentation and semi-opacity, all closely agree with the Synlestid type of gill. In addition, the gills are held by the living larva in the same manner as in the case of *Synlestes*, viz. with the three gills very slightly apart, the median one only slightly raised and the laterals only slightly depressed and diverging.

(*b*). *The gizzard.*—This resembles that of the Synlestidae and Lestidae in the arrangement of the teeth and their confinement to four major folds. These two families, however, possess gizzards with only eight folds (four major and four minor), whereas all other Zygoptera have 16-fold gizzards, while all the Anisoptera except the Petaluridae have 4-fold gizzards. The resemblance is closer to the Lestidae than to the Synlestidae.

(*c*). *The labial mask.*—The Synlestid characters of the mask are to be found in the prominent median lobe, with deep median cleft, and in the form of the apical tooth of the lateral lobe, and the finely crenulate inner border of the same.

(*d*). *The larval habits and colouration.*—These closely resemble those of the genus *Synlestes*, and the general facies of the larva can be said to be more Synlestid than anything else, though lacking the elongation of the body and antennae so noticeable in the genus *Synlestes* itself.

The above larval characters indicate a close affinity with the Synlestidae, but are greatly strengthened by a number of imaginal characters, such as the general facies, the metallic green colouring, numerous points of resemblance in the wing-venation, and particularly by the fact that *Chorismagrion*, a very close ally of *Synlestes*, is the only other known genus in which the quadrilateral is ever open basally.

(3) *Characters shared with the Lestidae.*

(*a*). *The gizzard.*—The resemblance of this to the Lestid gizzard has already been mentioned above. The presence of five large teeth on each of four major folds, the teeth being arranged in a transverse arch, is a striking Lestid character.

(*b*). *The presence of setae on the movable hook of the mask.*—This character has hitherto been found only in the Lestidae, which have either two or three strong setae on the movable hook. *Hemiphlebia*, with a single strong seta close to the base of the hook, here shows unmistakable affinities to the Lestidae.

(*c*). *The dentition of the lateral lobe of the mask.*—The division of the lobe into two large teeth and an irregularly denticulated process is closely paralleled by such species as *Austrolestes analis* Ramb. (Tillyard, 1917, p. 83, fig. 32, H), but the process is more evenly truncated and regularly crenulated in the latter, while the whole lobe is more broadened out and tends towards the spoon-shaped type. There is, however, no other type of lateral lobe which shows so close a resemblance to that of *Hemiphlebia*.

(4) *Characters shared with the Libellaginidae and Agriidae (Calopteryginae of de Selys).*

(*a*). *General form of the labial mask.*—In both groups this is very long and slender, and generally of similar shape. The median lobe in Libellaginidae (*Micromerus* and *Rhinocypha*, see Fraser, 1922, pp. 79-81, Pl. ix, x) is of the same form as that of *Hemiphlebia*, the median cleft perhaps not quite so deep, but slightly wider, and there is the same indication of a slight constriction or division between the median lobe and the mentum proper; the large prongs and the setae, however, are entirely absent. The very prominent and deeply cleft median lobe of Agriidae may be regarded as a specialization from the Libellaginid type.

As regards the lateral lobes, setae are developed at the base of these in both Libellaginidae and Agriidae, but never on the movable hooks. The form of the lateral lobe is elongated and slender, with large movable hook and two sharp teeth, with or without a smaller tooth between them. This type cannot be regarded as coming very close to that of *Hemiphlebia*.

(*b*). *General habits of the larvae.*—The habits of the larvae of *Hemiphlebia* and Agriidae appear to be closely alike. Both are sluggish creatures which cling to the bases of reed-stems, weeds, etc., in still or slowly moving waters, and have a dull colouration.

(5) *Characters shared with the Epallagidae and Polythoridae.*

(*a*). *Mandibles with distinct molar and incisor areas.*—These so-called "biramous" mandibles are admittedly archaic, and are characteristic of the Machilidae and the whole Order Plectoptera. They have been recorded for the Epallagid genus *Pseudophaea* and the Polythorid genus *Cora* (see Calvert, 1911, p. 56). The differentiation of the two areas is, however, more clearly marked in *Hemiphlebia*, in which the form of the mandibles approaches more closely to those of the Plectoptera than in any other known Odonate.

(6) *Characters shared with the Coenagriidae (Agrioninae of de Selys).*

As *Hemiphlebia* has always been classified with this family until I removed it in 1926, one naturally expects to find some close resemblances in the larval characters. But, curiously enough, none is to be found, unless one allows the purely negative character of the absence of any specialized tracheal formation in the larval wings giving origin to an oblique-vein formation in the imago, and, also, the resemblance of the truncated process of the lateral lobe of the labial mask to a somewhat similar process in most Coenagriidae, though the latter have no large tooth between the process and the movable hook. The general forms of the two types of mask are very distinct, and the same is true of the gills, gizzard and other larval structures. One can only conclude that the genus *Hemiphlebia* was wrongly placed by de Selys, and that no close relationships exist between it and the Coenagriidae.

The general conclusions which we may make from the above facts are that the larva of *Hemiphlebia* is an exceedingly archaic type, probably by far the most archaic larval type of Odonata still existing; it shows a closer relationship with the larval forms of the Order Plectoptera than might reasonably be expected, though that relationship is still a distant one, indicating a common ancestor very far back; it shows, more particularly, a very close relationship with the Synlestidae and Lestidae, and is properly to be placed close to these two families in any scheme of classification. The erection of the family Hemiphlebiidae appears to be

more than justified on the larval characters alone, and the family may legitimately be regarded as a remnant of an exceedingly early type of Zygoptera, closely related to the known Permian forms, and thus not really very far removed from the original types (now lost) which gave origin to all the greater groups of Odonata, viz. the Coenagrioidea, Agrioidea, Anisozygoptera, and, through them, the Anisoptera.

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THE PHYSIOGRAPHY OF THE COX RIVER BASIN.

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(Plates xix-xx, and seventeen Text-figures.)

[Read 30th May, 1928.]

Introduction.
Area dealt with; Previous work and literature; General considerations.
Classification of Regions.
Blue Plateau; Jenolan Plain or Plateau; Wallerawang and Lithgow valley levels; Kanimbla and Megalong Valleys; Jamieson's Valley and the Kowmung Basin; The Monadnocks.
Geology of the Area.
Main structural features; Ancient ranges and peneplains; The rocks, and their resistance to erosion.
Dominant Physiographic Features.
Blue (Mt.) and Jenolan Plateaux; Kanangra Platform; Wallerawang and Lithgow Valleys; Boyd and Budthingeroo Creeks; Retreat, Tuglow and Fish Rivers; Kanimbla and Megalong Valleys; The relationship between the Kanimbla and Wallerawang Levels; Jamieson's Valley and the Kowmung Basin; Valleys of the Lower Cox-Wollondilly; The Warragamba Gorge.
Main Folds and Warps of the Area.
General considerations of the folding; The Mulgoa Step; The Kowmung Warp; Extent and external relationships of the Kowmung Warp; The old Blue (Mt.) Anticline; Direction of forces causing uplift.
Streams of the Area.
Stream Characteristics and Relationships; Divides of the Cox (Solitary Creek; Bindook Swamp); Cox River and its Tributaries (Relative stream ages; Anomalies of direction); Relationship between the Kowmung and Wollondilly; History of the stream system.
Past History of the Area.
Earth Movements; Stream History.
References.

Introduction.

This paper treats of the rough Blue Mountain Plateau, a good deal of which is very little known. It commences with an examination of topographic features, and the influence of rock structure on these is traced. It is then possible to divide the area into a number of small parts according to form and development of surface features. The evolution of each part is traced, and the parts correlated. In this way the earth movements which have affected the area are discovered and explained. In the light of the knowledge thus obtained the development of the stream system is traced, and the past physiographic history of the area is outlined.

The research work which this paper describes was undertaken during 1926 under the supervision of Professor Griffith Taylor, to whom my thanks are due

for his great interest in the work, and for many suggestions of his which are embodied in this paper. Much of its merit is due to him, and to his continual encouragement. Next, I have to thank Miss W. Riley, of Leura, for most of the printing on the diagrams. Messrs. H. C. Allen, B.Sc., and C. H. Black, B.Sc., assisted in the work on Jamieson's Valley in very bad weather, and I owe a great deal to them. The Water Conservation and Irrigation Commission has also supplied a valuable map and other information.

Text-Fig. 1.—The Cox River Basin.

Block Diagram of the Area. This summarizes the topography. The plateau masses are trenched by narrow gorges and valleys on the south and east, whilst broad, mature valleys, which are now being trenched by the streams, are found in the centre and north of the area. The great Kowmung Canyon is very striking.

My very sincere thanks are also due to many residents of the area who assisted me in a variety of ways. I would like to mention particularly Messrs. Bulkeley (Wallerawang); Kirby and Carlon (Megalong); Maxwell and Kill (Kedumba or Jamieson's Creek); and James and Kerswell (Lower Burragorang); together with their wives and families. Many others have also earned my hearty thanks, and I would pay a tribute to their kindness and helpfulness, without which it would have been impossible to examine all the area which is here described.

Area dealt with.—In this paper, the Cox River Basin is taken to include that area of country drained by the Cox and Kowmung Rivers and their tributaries, together with the Warragamba and Lower Wollondilly Rivers. The latter streams are included because the problems associated with them are intimately related

to the problems presented by the Cox. This embraces an area of some 1,600 square miles.

Previous work and literature.—The area has not been treated previously, as a whole, in any detail. Mr. Andrews and Professor Griffith Taylor have written valuable papers on the general physiography of the area, and intensive research tends to prove many of their theories. The geology of the country adjacent to the Main Western Railway and the Lithgow Coalfield is fairly well known, but the geology of the rough Kowmung, Kanangra and Jenolan River basins, and Mt. Mouin district has not been studied. Some observations on this phase of the subject are embodied in the paper.

General considerations.—The Cox River area includes some of the wildest and most broken country in this State; and has, since the earliest days of white settlement, proved to be a great obstacle in the way of free communication between Sydney and the interior—not so much on account of the altitude involved, but because of the profound recent dissection of a moderately uplifted surface. The great gorges which the main streams have cut have, in general, a north-south trend across the radial lines of communication from the Sydney Basin, and only where persistent east-west ridges occur, as in the case of the Glenbrook-Clarence watershed, is the relatively easy construction of roads and railways possible.

Classification of Regions.

A study of the Block Diagram (Text-fig. 1) will show that the area includes a number of dissimilar physiographic types. The streams of the Upper Cox flow to the east in broad, flat valleys which have, however, a general outlet to the west, into the Macquarie basin. The Middle Cox basin consists of a series of broad, flat valleys which have been trenched by deep juvenile gorges; whilst the Lower Cox and its associated streams flow from the wide valleys into deep, narrow trenches, finally debouching on the plains of the Sydney Basin. Thus the area appears to fall into a number of well-defined natural regions, which are determined mainly by differences of elevation. There are six of these regions, which vary notably from one another, and whose characteristics will now be described.

(i). *The Blue Plateau.*—In this paper, the term "Blue Plateau" will be used in a restricted sense. The plateau extends from the Hunter River Valley in the north to Lake George in the south and can, in a general sense, be described as a topographic unit and have the name "Blue Plateau" applied to it. Here, however, the term will be used to designate that elevated sandstone block which in parts rises to 3,500 feet above sea-level, and occupies all of the northern and eastern parts of the area, together with the lower warped country leading up to it. This region has three well-marked subdivisions, viz., the lower or Mulgoa "step", extending from Glenbrook to the south of The Oaks; the King's Tableland "step", extending from Hazelbrook in the north away beyond Oakdale in the south, including the country to the east of Jamieson's Creek and the Lower Wollondilly; and the main plateau, varying from 3,000 to 3,500 feet in elevation, and extending westwards from a line joining Katoomba with Mounts Hay, Tomah, Wilson and Irvine. Between these steps are stretches of uniformly-sloping land. This plateau is essentially a recently-warped peneplain, and is deeply dissected in parts.

(ii). *Jenolan Plain or Plateau.*—This region consists mainly of soft Silurian rocks. It is about 700 feet higher than the main mass of the Blue Plateau, whose average elevation is about 3,300 feet. The Jenolan Plateau extends vertically from

3,700 to 4,400 feet above sea-level, having an average elevation slightly in excess of 4,000 feet. Its surface is generally very level, but is trenched in the east and north-east by deep gorges. This plateau extends from Sunny Corner south-eastwards to Kanangra Walls, and westwards to the Stony Ridges near Bathurst.

(iii). *Wallerawang and Lithgow Valley Levels.*—The area of flat late mature valleys at an elevation of 3,100 feet centring on Wallerawang comes under this heading, and includes the Lithgow, Portland, Wallerawang and Solitary Creek Valleys, together with similar higher valleys to the south, on Boyd Creek and the Upper Tuglow, for example. It will be seen, from the outset, that these valleys are cut in a variety of rocks.

(iv). *Kanimbla and Megalong Valleys.*—The middle course of the Cox, between Lett River and the Narrow Neck-Gangerang Range line, is marked by a great series of upland valleys. These occur at elevations varying from 1,900 to 2,500 feet, having an average elevation of 2,200 feet. The valley floor is geologically varied, consisting of granite, conglomerate, sandstone, and certain slates, etc. The valley itself contains some alluvial deposits to the north of the Cox, and is, physiographically, of great interest. On the eastern margin, the river leaves the valley by a great canyon which is, for nineteen miles, nowhere less than 2,000 feet deep.

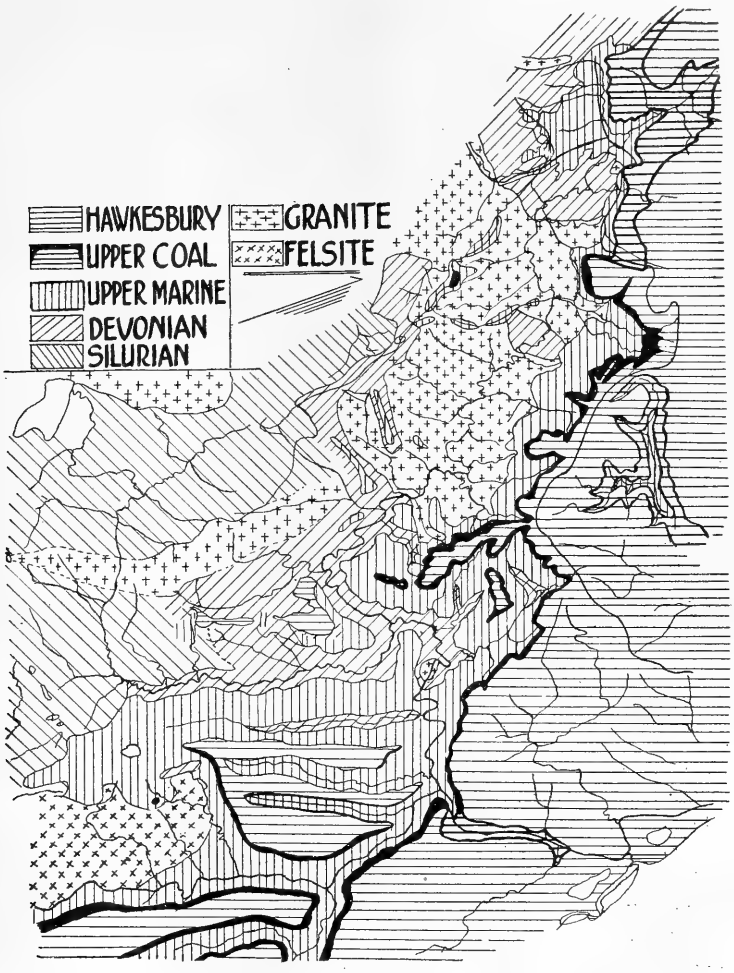
(v). *Jamieson's Valley and the Kowmung Basin.*—Jamieson's Valley and the Kowmung Basin form a great oval-shaped valley, which is divided into two parts by the Cox River. The river does not, however, destroy the unity of the feature. The lower part of Jamieson's Valley is only 500 feet above sea-level, but a steadily-rising warped surface extends to the west, south-west and south of the small stream flats, rising to 2,300 feet on the Megalong level at Megalong Gap; and to 2,800 feet at Bindook Pass, on the southern divide of the Kowmung. The uniform warped valley floor is trenched by the Cox and Kowmung Rivers. The warping affected the mouth of Jamieson's Creek in a manner which will be discussed later.

(vi). *The Monadnocks.*—Rising above the respective surfaces of the plateaux are a number of monadnocks and residuals. These may be classed under two headings—the basalt residuals and the quartzite blocks. The former occur mainly along the southern divides of the Kowmung, and include Mounts Werong, Colong and Shivering, South Peak (Yerranderie), Harvey's Mount and a large area around Shooter's Hill. The old quartzite peaks are Mounts Walker, Flaherty, Bindo, Lambie and the Gangerang Range. The former appear to be relics of an ancient peneplain, but the latter are monadnocks that have existed through long periods of geological time on account of their great resistance to erosion. They are discussed more fully in other parts of the paper.

Geology of the Area.

Main Structural Features.—The rocks of the area are divisible into two main classes, namely, (i) Mesozoic and Upper Palaeozoic and (ii) Lower Palaeozoic. The former occupy the northern and eastern parts of the area; the latter occur in the centre, south-west and west. The Triassic and Permian beds (Hawkesbury and Narrabeen Series, Upper Coal Measures and Upper Marine Series) rest unconformably upon the older strata, and there is a definite line of demarcation between the present outcrops of the two. This line runs, roughly, along the Kowmung Valley, across the Cox, and on the northern side of Kanimbla Valley. The area to the west of the line would thus appear to have had a predominantly

upward movement since Devonian times, whilst the country to the north and east would appear to have been an area of relative depression. Thus some of the earth movements which are postulated in this paper appear to be renewals of these ancient earth movements, as the south-west (Jenolan Plateau) has undergone greater recent elevation than the remainder of the area.



Text-fig. 2.—Geology of the Cox Basin.
The eastern and north-eastern parts are very much younger, geologically, than the western portion. The former represent the old regions of relative depression, whilst the latter represent areas of long-continued relative uplift.

The geological structure is thus readily understood (Text-fig. 2). Various outliers of the newer rocks are found on the older, higher rocks of the Jenolan Plateau; and these shed light, not only on the past geological history of the area, but also upon recent warping movements that have affected it. Two groups of out-

liers may be particularly noted—those along and adjacent to the Main Divide between Rydal and Jenolan, and those to the east of Kanangra Creek.

The first group consists of a series of outcrops strung out along the Main Divide between Rydal and Hampton, along some of the ridges running north and south from the Divide, the most notable being between Lowther and Hartley.

The relics belong to the Upper Marine Series, and consist mainly of sandstone and conglomerate. They rise from 3,100 feet near Rydal to 3,950 feet three miles to the north of Hampton, and 4,200 feet about three miles to the south-east of Jenolan Caves. At Hartley these rocks are found as low as 2,400 feet, but they rise 1,400 feet to Hampton, which is twelve miles distant at 3,800 feet.

The most interesting member of this group is that outlier which is found three miles to the north of Hampton. It stretches for two miles along the Main Divide, and attains a maximum thickness of 350 feet. It consists of conglomerate, shale, sandstone and, at the top, a bed of grey shale containing a six-inch band of coal. The latter is found right on the crest of the ridge, 3,950 feet above sea-level. The highest outcrop of coal on the western coalfield is at 3,200 feet at Piper's Flat, so there is a difference in elevation between the two of the order of 750 feet. This represents the extra amount of elevation which the Hampton beds have suffered compared to the corresponding rocks of the main Blue Plateau around Wallerawang; it is also equal to the difference in elevation between the Blue and Jenolan Plateaux.

Warping of the country between Hartley and Hampton must certainly have taken place unless one is prepared to assume that the conglomerate beds could have been laid down at and along the present slope, which is approximately 120 feet per mile.

The second series of outliers occurs to the east of Kanangra Creek, at Kanangra Walls and along the Gangerang Range. The newer sandstone is horizontal, and rests unconformably upon the older folded beds. Kanangra Walls are formed by the weathering of this rock along a major joint plane. The sandstone, whose upper surface is at 3,300 feet, attains a maximum thickness of 250 feet, and extends northwards along the eastern side of the Gangerang Range, appearing as a broken bench on the side of the high quartzite residual, which rises to 3,700 feet.

The age of this sandstone is doubtful. On the Geological Map of N.S.W., 1914, it is marked as belonging to the Upper Coal Measures. It extends at the 3,300 feet level along Gangerang Range, and appears to correspond to the Hawkesbury Series on Narrow Neck, Katoomba, at 3,400 feet. The presence of a coal band and the reputed occurrence of *Glossopteris* indicate that it does not belong to the Hawkesbury Series. The difference of elevation of 600 feet between this and the Hampton rocks may be remarked on as a sign of differential uplift.

Ancient Ranges and Peneplains.—From very early times the crust of the earth in this area has been in a state of unrest. The Silurian and Devonian beds are unconformable, and have been greatly crushed and folded. Since the close of the Carboniferous there has been relatively little folding, the earth movements having been more of a vertical character.

The geological history of the area opens with the Silurian sedimentation, when an extensive series of limestones, shales and interbedded volcanics, with subsequently-metamorphosed slates, was formed. A period of uplift and erosion was followed by further downthrust and sedimentation in the Devonian period.

The Devonian beds are now of a predominantly metamorphic character, consisting of quartzites, slates, shales, and intrusive porphyries.

At the close of the Devonian there was a great period of mountain-building, accompanied by the intrusion of a batholith of granite, quartz-porphyry dykes, and regional metamorphism. The country was intensely folded into a series of symmetrical synclines and anticlines, the relics of folding being still plainly visible. With the movement of uplift dominant, the land was kept above the sea, and a great cycle of erosion resulted in the reduction of the folds, and the formation of a peneplain. So great was the amount of erosion, that areas of the intruded granite were exposed. The harder rocks, such as Gangerang and Mt. Walker, persisted as peaks, up to 2,000 feet above the softer rocks of the peneplain, which formed gently-rolling plains. Some of the peaks exist at the present time.

At the close of the Carboniferous, a downward movement of the land interrupted the cycle of erosion. This movement was more intense in the east, and hardly affected the western part of the area. The Upper Marine beds and Upper Coal Measures were laid down unconformably on the upturned eroded edges of the slates, and quartzites, and on the granites. Until the close of the Triassic, the eastern part of the area continued to be depressed, but the western part appears to have been lifted above the sea at the close of the Permian. Since the deposition of the Hawkesbury, Narrabeen and Wianamatta beds—the latter only occurring on the eastern margin of the area—the major movement has been one of uplift. The earliest uplifts have all been obscured by those coming subsequently, and it is not until the period of basalt flows, probably later than Middle Tertiary, that we get a distinctive peneplain preserved. This is now represented mainly by isolated basalt areas and caps, a few of which, e.g., Mounts Colong, Shivering, Werong, Clarence, and the country near Shooter's Hill, are found in this area.

The great Tertiary Peneplain, which now forms the plateau surface, was probably formed in the latter part of the Tertiary period. The history of the land surface subsequent to this peneplanation, is most readily traced by physiographic methods.

The Rocks, and their Resistance to Erosion.—Reviewing the rock structures of the area, one is struck by the great resistance to erosion shown by the majority of the rock types. The younger sedimentary rocks—Triassic and Permian—are here near their western limits, and so consist mainly of sandstones, grits and conglomerates. The Hawkesbury Sandstone and Narrabeen beds are here practically all sandstone and grit, with only thin bands of shale. In general the Upper Coal Measures are soft, consisting of shales and crumbling sandstones, as in Jamieson's Valley and around Lithgow. Nearer their periphery they, too, are very hard. To the north of Piper's Flat the surface of the Blue Plateau is of hard Coal Measure sandstone (containing *Glossopteris*). On Mt. Mouin, and the ridge to the south-west of Yerranderie, these series consist mainly of resistant grits. At Wallerawang and Marangaroo also the basal beds—the Marangaroo Conglomerate—are very hard, forming cliffs where softer shale bands are cut away from beneath them.

The Upper Marine beds are also, in general, very resistant to weathering in such places as the Kanimbla and Wallerawang districts, where conglomerate and sandstone are predominant. To the east, as in Jamieson's Valley, a considerable thickness of shale and tuff also occurs. The basal deposits often contain small

deposits of alum. In parts, as in Megalong, there are bands of pebbles in a crumbly matrix, in which this alum is found. On the whole, the Upper Marine Series is very resistant to erosion in the west and south, and moderately resistant in the north-east.

The older rocks are principally igneous and metamorphic. Of these, the Devonian slates and quartzites are uniformly hard, whilst the Silurian slates and shales are much softer. One particular bed of the Devonian series, a white glassy quartzite which occurs on Gangerang Range and Mt. Walker, is particularly resistant. Practically the only natural means of disintegration is by the freezing of water in joint and bedding planes, which splits the rock up into cubes, with edge up to a foot, and which litter the mountain sides. The Devonian slates, too, are hard. On Breakfast Creek, for example, there has been no appreciable differential erosion in the slates and quartzites. The Silurian slates and shales are soft, giving a subdued topography, as on the uplands near Jenolan Caves, and forming characteristic saddle ridges as on the Kowmung-Wollondilly divide. The roots of falling trees, blown over by the wind, tear great holes in these rocks, which are generally strongly jointed and laminated. Despite the softness of its rock types, the Jenolan Plateau stands up as a high block, and so cannot be a mesa, or relic of a separate peneplanation older than that of the Blue Plateau.

The granites of the Cox Valley vary in hardness from place to place, but are generally not very resistant to erosion, on account of their susceptibility to chemical weathering. Where caps of Upper Marine sandstone occur in the valley, hills are found; but where the sandstone has been worn away, the granite is quickly eaten down, forming typical rolling hills. Above Galong Creek (Megalong Valley) for instance, the Cox is entrenched in undulating granite hills. Below this stream it flows into an extremely steep-sided ravine of Devonian strata. A small boss of granite is exposed on the Lower Cox below Jamieson's Creek.

The rocks can thus be classified in descending order of resistance to erosion as follows:—

i. Devonian quartzite and indurated conglomerate (latter on Jamieson's Creek). Basalt caps.
ii. Hawkesbury and Narrabeen sandstones; Upper Marine sandstones and conglomerates; some Upper Coal Measure sandstone.
iii. Devonian slates and intrusive porphyries.
iv. Granites, in general.
v. Silurian slates, shales, etc., in general.
vi. Upper Coal Measures; interstratified shales in the Upper Marine, Hawkesbury, Narrabeen, and Devonian Series.

Only the last two types are distinctly soft. It will be seen that the great mass of soft rocks on Jenolan Plateau lies away from the great Cox and Kowmung Valleys, which have been cut in almost uniformly hard rocks. The effect of this has been to reduce differential erosion to a minimum in the formation of the broad valleys.

Dominant Physiographic Features.

Blue (Mt.) and Jenolan Plateaux.—The Blue Plateau has been recognized by geographers and physiographers as part of an uplifted and dissected peneplain. Mr. Andrews originally regarded the Jenolan Plain as a relic of a more ancient cycle of erosion than that which formed the Blue Plateau (Geography of Blue

Mts.), but has since modified his views on the subject in general. He says (Geog. Unity of Eastern Australia, pp. 433-434): "It would appear, in fact, that wherever in Eastern Australia two unreduced plateau masses exist side by side at variable altitudes, a fault or sharp fold separates them". And again, "The same horst (i.e., west of Burragorang) exceeds 4,000 feet a few miles east of Bathurst, and the Bathurst Plains (2,500 feet) appear to be a senkungsfeld dropped between Orange and the Sunny Corner Highlands". There appears to be strong field evidence in support of these views.

The peneplain as an Australian feature is discussed by Dr. Fenner (Physiography of Werribee Area, p. 203, et seq.). He, in common with many other writers, whom he quotes, holds that the Tertiary peneplain is the dominant feature of the Australian highlands. The uplifted and dissected peneplain is represented in this area by the Blue and Jenolan Plateaux.

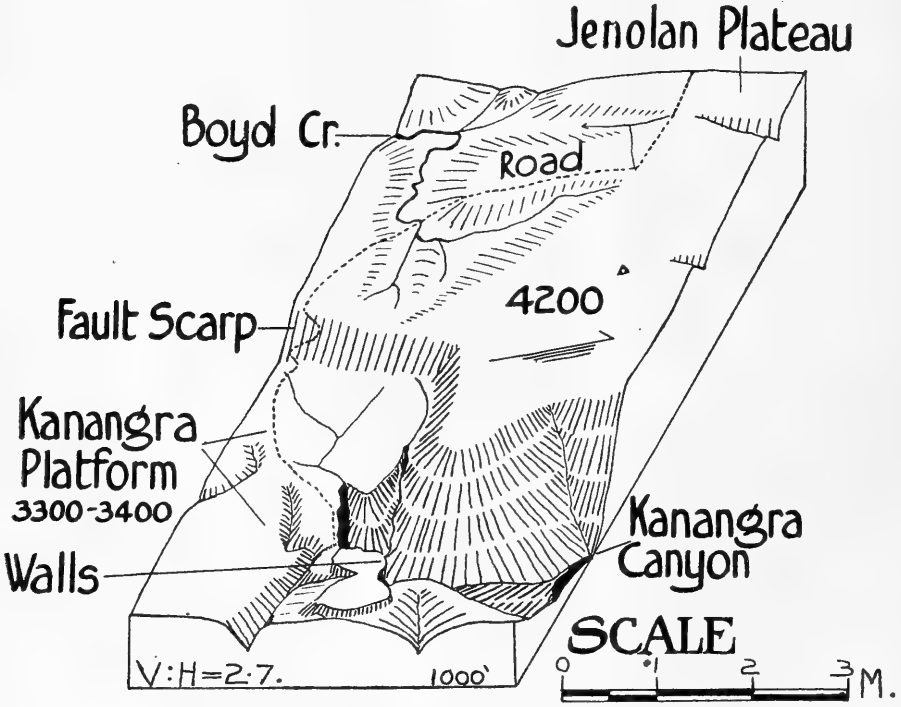
There are two main lines of evidence which seem to indicate that these two surfaces belong to the same cycle. Firstly, there is the relative hardness of the two masses. The surface of the Blue Plateau is composed of hard sandstones, but the Jenolan Plain is mainly composed of soft shales and slates. The presence of these rocks has resulted in very subdued topography in regions as yet unaffected by headward erosion caused by the upwarping of the plateau, the country around Hampton being typical of this. If the Jenolan Plain were a mesa, or relic of a one-time complete peneplain, one would expect the rocks of which it is composed to be hard and resistant to erosion. This, however, is not the case. There is evidence, both geological and physiographic, of recent differential uplift of the Jenolan Plain above the Blue Plateau. The latter has an elevation of 3,300 to 3,400 feet, whilst the Jenolan Plateau has an average elevation of 4,000 feet, varying from 3,800 to 4,400 feet; that is to say, the latter is, on the average, 700 feet higher than the former. A certain amount of local differential uplift of the Jenolan Block itself is probable, as it exhibits a wavy surface.

The greater elevation of the Jenolan Plateau is due to uplift which has not affected the Blue Plateau to the north and east. The outlier of Coal Measure rocks at Hampton, 700 feet above corresponding rocks at Lithgow, has already been noted. The only other explanation of this difference in elevation is an assumption that this rim of the coal basin saucer rises 700 feet in a few (7) miles, the direct distance between this outlier and similar rocks at South Bowenfels; which seems improbable, especially when considered in connection with the sandstone at Kanangra at 3,300 feet, just off the eastern margin of this Jenolan Plateau.

There also appears to be topographic evidence of both warping and faulting on the southern side of Kanimbla Valley. On the northern side of the Cox are the Kanimbla levels at 1,900 to 2,500 feet. On the southern side there is a uniform slope from this height right up to the Main Divide at 4,000 feet, thus giving the Cox a valley which is asymmetric about the river; this slope consists mainly of granite, with a few outliers of Upper Marine rocks. There does not appear to be any obvious reason why this rock rises to 4,000 feet on the divide when it occurs in Kanimbla at 1,900 to 2,500 feet, and is there subhorizontal, other than that given by the explanation that these uniformly-sloping ridges were once more level than now, and have been tilted by warping, thus giving the Cox its asymmetric valley. The Upper Marine rocks were apparently deposited on a granite peneplain, formed during the long period of erosion succeeding the Kanimbla Epoch of mountain building; and it does not seem that these con-

glomerates would be deposited along a steeply-sloping surface of fairly soft rock in such a position as that in which they are now found. In passing, it may be noted that the Kanimbla conglomerate, in common with the other Permian and Triassic strata, dips to the east, and an upward slope from north to south begins only to the south of the Cox, in the supposedly warped area.

This slope of the southern ridges is also noticeable in the case of the Black, Jenolan, and Mini Mini Ranges. Below Galong Creek, there is a marked discontinuity of slope in the Upper Marine beds as one goes from the north to the south of the Cox River. To the east of the River, the beds are practically horizontal, but on the western side they dip steeply northwards. The Cox flows a little to the south of this line of discontinuity, which may also be marked by slight faulting. There appears to be a slight vertical displacement here, but this cannot be definitely asserted.



Text-fig. 3.—Physiographic Fault at Kanangra Walls.
This fault is a revival of the old fault lines noted in Text-fig. 2, between the rising area to the west and the sinking area to the east. Kanangra Canyon is cut along this fault.

On the east the Jenolan Plateau is bounded by a definite scarp, which, although hardly recognizable as such in places, owing to confusion with the western margin of the Kowmung basin, is, nevertheless, fairly well defined (Text-fig. 9*C*). Perhaps the best place for observing this scarp is from the edge of "Big Plain" (4,000 feet), which is situated on the Kowmung-Wollondilly divide, about three miles to the west of Mt. Shivering. To the east of the plain, along

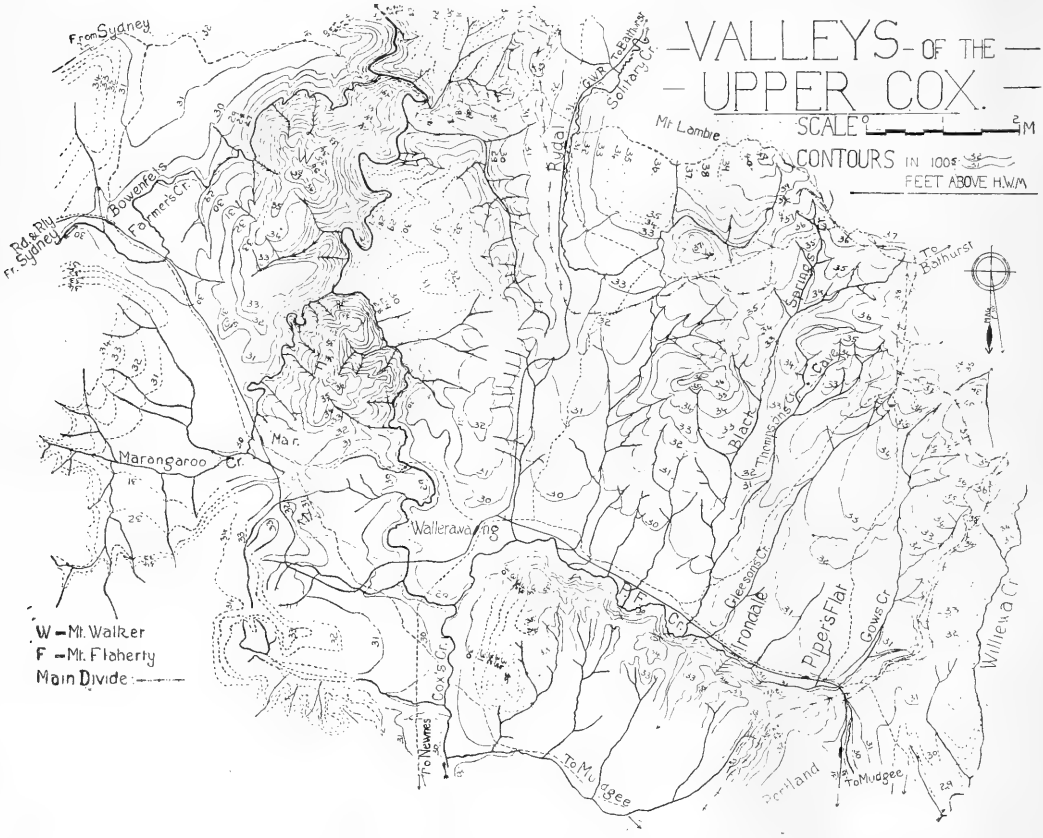
the dividing ridge, the land falls away steeply to 3,500 feet near the Mount, and thence, in a series of steps, to Bindook Swamp, at an elevation of 2,800 feet, which is some 300 feet below the surrounding country. Away to the north, a low scarp can be seen rising above the level of Kanangra Walls (Text-fig. 9*C*). This scarp rises to 4,300 feet, and forms the eastern edge of Jenolan Plateau. Between "Big Plain" and Kanangra Walls the scarp is much cut up, being trenched by great juvenile gorges.

On the west, the Jenolan block appears to be bounded by a definite scarp, part of which is the Stony Ridges to the east of Bathurst, as Andrews (1910) points out. From these considerations it appears that the Jenolan Plateau is composed of a broad, dome-shaped warp, which has been faulted along its north-eastern, eastern and southern edges.

I do not propose to describe the Blue Plateau in detail, as its salient features are already fairly well known. It consists of portion of an upwarped, slightly dissected peneplain, which is being trenched by stream action, resulting in the formation of deep, narrow canyons. A part of this has been described by Taylor (1923*a*). The plateau does not rise uniformly from east to west (Text-fig. 12), but, as Taylor points out, it exhibits "Steps" or "Treads", one at Mulgoa and one at Hazelbrook, both of which are very definite. Their respective elevations are 500 and 2,200 feet. The main change of slope occurs along a north-south line which runs through Katoomba, Mts Hay, Tomah and Wilson. To the east of this line, the average grade of the warp slope is of the order of 125 feet to the mile. To the west of this line, however, the slope rarely exceeds 20 feet to the mile. On the west of this line, therefore, the true plateau surface is found. Whilst these steps may be due to differential warping during a single period of uplift, their occurrence is not inconsistent with the theory, suggested by Taylor, that the present plateau surface has been formed by a series of non-contemporaneous warps and folds, and represents the algebraic sum of the same. This view has also been held by Mr. Andrews and the late Mr. Hedley.

The Kanangra Platform.—The two plateau levels are found in close proximity to one another at the head of Kanangra Creek, 20 miles to the south-east of Jenolan Caves, where the Kanangra "Platform" (Text-fig. 3) is located. Two main surfaces are found here, the upper being part of the Jenolan Plateau at an elevation of 4,000 to 4,250 feet, the lower level or Kanangra Platform having an elevation of 3,300 to 3,400 feet. The former consists of folded Silurian rocks, bevelled off across the bedding planes and granite, as on Boyd Creek. The mature upper valleys of Budthingeroo and Boyd Creeks are incised 300 to 500 feet in the plateau. The Kanangra Platform consists partly of horizontal sandstones, and partly of planed-off slates and quartzites. There is no change in slope or topography in the passage from one series to another. The upper valleys of Kanangra Creek are very little entrenched in this hard surface. Between these two levels there is a very definite scarp, 600 feet high, down which the road winds. It has hardly been cut into in this part by the small wet-weather streams. To the north, this scarp forms the western side of the great Kanangra Canyon. Kanangra Creek has taken advantage of the fault line, and has carved out a gorge which is 2,000 feet deep at the Walls, and somewhat over 3,000 feet deep between Gangerang Range and Mt. Guouogang. The streams plunge abruptly into this canyon from the platform in a series of high waterfalls, descending 1,500 feet in a mile.

To the south, the scarp consists largely of softer rocks, and has been deeply cut into by the powerful Kowmung streams, but it is still plainly discernible (Text-fig. 9*C*). The 3,300 feet level is found along Gangerang Range on the eastern and northern sides. The peaks rise above this bench as monadnocks. Although approaching the Jenolan Plateau in elevation, Gangerang is a separate feature, and has only recently been made to appear comparatively low by the rise of the Jenolan block to the west of the fault. At Kanangra Walls therefore, the two plateau surfaces are found together, separated by a sharp fault. Comparatively recently, we conclude, the two surfaces were at the same level. The fault scarp continues south into the Wollondilly basin, but passes into a fold further to the north, in the Kanimbla Valley.

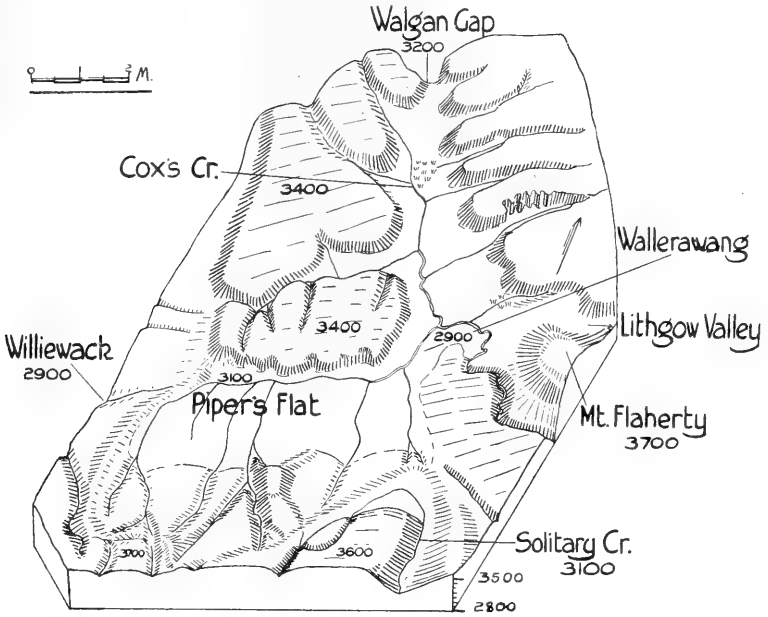


Text-fig. 4.—Contour Map of Wallerawang District.
Note the mature valleys broken only by the ancient monadnocks of Mounts Walker and Flaherty, the entrenched meanders of the Cox, and the asymmetry of the valley of Piper's Flat.

Wallerawang and Lithgow Valleys.—The upland valleys around Wallerawang and Lithgow form part of a valley system which extends across the Main Divide at Rydal and Piper's Flat, and includes the upper valleys of the Turon and Fish Rivers. In considering these valleys around Wallerawang, therefore, it is neces-

sary to remember that they are types of a valley-system which is not confined to the Cox basin. I propose to apply the name "Wallerawang Valley" to that valley about the 3,000 feet level which centres on Wallerawang, and extends from Wolgan Gap and Portland to Rydal and Wallerawang. "Lithgow Valley" will be defined as the valley stretching from Lithgow to Marangaroo, with a branch extending to the east of Mt. Walker towards Rydal.

The topography of these valleys and the associated plateau regions is clearly shown in the contour map (Text-fig. 4) and block diagrams (Text-figs. 5 and 7). The two valleys are actually continuous, but the monadnocks, Mounts Walker and Flaherty, which rise from 700 to 800 feet above the valley floor, divide it into two parts.



Text-fig. 5.—The Head of the Cox.
The broad valley of Piper's Flat Creek extends over the Main Divide into the Turon Basin. The southern margin has been affected by recent warping. The hard rocks of the plateau have been formed, by long continued erosion, into subdued ridges and mature valleys.

Wallerawang Valley, on the western side, varies in elevation from 2,900 feet at Wallerawang to 3140 feet and 3150 feet at Piper's Flat and Rydal respectively, and 3,175 feet in Wolgan Gap. The width of the valley along Piper's Flat varies from two to four miles, and the average depth is of the order of 400 feet. The valley of Cox's Creek is narrower, but of the same general depth. In general character the Wallerawang Valley is mature and, in common with the surrounding plateau, geologically varied. The valley floor is composed of Upper Coal Measure shale, Upper Marine shale, sandstone, and conglomerate, Devonian shale and quartzite, and granite. The plateau consists of Devonian quartzites and shales, Upper Coal Measure shales and sandstones (the latter to the north of Piper's

Flat), Hawkesbury sandstone, and granite. There has been little differential erosion between these rock types.

There is a gentle uniform rise along Cox's Creek, for example, from Wallerawang to Wolgan Gap, over Upper Marine, Upper Coal Measure and Hawkesbury rocks. The junction of different series cannot be detected by change of slope. A similar thing is true of ridges in this valley that run down towards Piper's Flat from the southern side. A traverse along the Main Divide to the south of Piper's Flat takes one over Upper Marine and Devonian rocks and granite. Again there is no notable change in topography with change in rock type. The hard sandstones now found on the plateau to north and west of this valley once extended right across the valley, as the outlier of sandstone on Round Hill (3,720 feet) on the southern side of the valley shows. This mature valley cannot, therefore, be ascribed to differential erosion in rocks of varying hardness, but must be the result of prolonged erosion when the land surface was not far above base-level, before the main uplift which formed the present plateau.

One of the most striking topographic features of the district is the asymmetry of the main valley, that of Piper's Flat Creek. The northern side of this valley, from Wallerawang to Portland, is a steep scarp against whose base the main stream flows. The southern side of the valley rises gently and uniformly, and is little cut into by the swampy streams that flow down it. The main stream receives no tributaries at all from the north, as the divide on that side is, in general, less than half a mile away. This feature has no apparent explanation, although there may have been a gentle uplift to the south, near Mt. Lambie, causing the stream channel to migrate northwards.

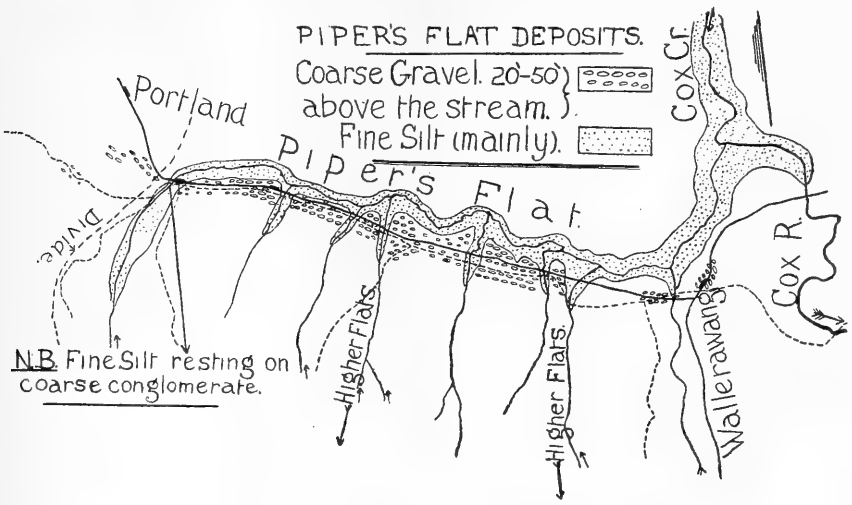
The valley of Cox's Creek is not so large or important as the other branch of Wallerawang Valley. Near Wallerawang, it is two miles wide; four miles above the town, however, it is but a half-mile wide, and narrows further towards Wolgan Gap. The same stream, which is the largest single stream in the head valleys of Cox River, is very little entrenched in its valley. Indeed, in parts, its tributaries have no definite channels through the swamps.

The streams of Wallerawang Valley differ somewhat in character. Cox's Creek and its tributaries run over swampy silt flats, and swing backwards and forwards over the valley. Piper's Flat Creek has a grade of about 30 feet to the mile, and is grading down its channel and cutting away the silt flats which it had previously deposited, which are up to a quarter of a mile wide. These silts are found along the tributaries up to four miles away from the main stream. On Thompson's Creek, for example, four miles from its mouth at Irondale, the silts are about 80 yards wide, and at least 10 feet deep, and are built up of peaty material at an elevation of 3,300 feet, 300 feet above the main valley. The streams are now just beginning to attack their head silts at 3,200 to 3,300 feet. These silts are found on most of the other tributary creeks of the valley, and on Solitary Creek, about two miles above Rydal.

One of the most interesting features of the valley is the occurrence of a line of gravels along Piper's Flat, up to 50 feet above the modern silt flats, and up to 30 feet thick. These gravels are found in a well-defined belt along the southern side of the valley (Text-fig. 6) extending over the Main Divide at least to the outskirts of Portland. Characteristic deposits may be seen near Wallerawang station and in the railway cuttings around Irondale. The pebbles vary in size from a couple of inches to a foot or more in length along the major axis, and are

ellipsoidal in shape. Grey and brown quartzites, the latter being spheroidal in shape, and containing beautiful specimens of *Spirifer* and *Rhynchonella*, various porphyries, some sandstone, and pebbles of decomposed rock containing mica, which might be weathered granite, are characteristic. They are much larger than the pebbles occurring in the lower silts and in the modern stream channel. The extension of the gravels over the Divide is interesting. The biggest boulder observed is found embedded in clay in a cutting right on the main Divide. It is porphyry, and is four feet high and two feet across.

The gravels are found on a variety of local rock types. Around Wallerawang, for instance, they are deposited on shale. In the vicinity of Irondale (e.g., at the mouth of Thompson's Creek) the local rocks are sandstone and grit. On the Main Divide, again, shale is found. It is apparent that the homogeneous gravels

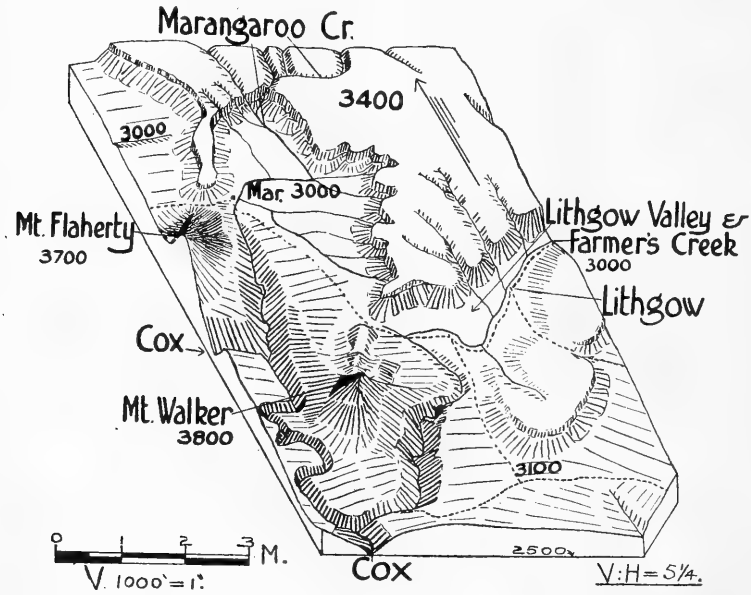


Text-fig. 6.—The Piper's Flat Deposits.
A line of gravel extends right along Piper's Flat over the Main Divide. Consideration of a number of factors shows the possibility of it being river gravel.

could not have been derived from the rocks on which they rest, although every rock-type found in them may have come from the district. The conclusion is, therefore, that they represent an old stream line about 50 feet above the modern flat, and have been put in their present position by stream action. Possibly, in time past, they extended over the area now occupied by the lower Piper's Flat.

An interesting confirmation of this view is obtained from Slaven's Cave, four miles up Thompson's Creek. This cave is situated on a hillside in hard porphyry, and was probably formed by the dissolving out of a small limestone pocket. Part of the roof has fallen in, but the cave is still about thirty yards across, and twenty to thirty feet high. A small hole leads into it from the top. The floor, which is about sixty feet above the modern stream, is covered with fine brown laminated silt, although now no water flows through the cave. Other unexplored caves occur below. The floor of the cave represents a higher old stream-level, which agrees with the evidence of the gravels.

In considering the character of the gravels, other points have to be borne in mind. Near Piper's Flat railway station, on Gow's Creek, coarse conglomerates are overlain by fine silts. Right along the southern side of the valley the soils are fine, with a few small quartzite pebbles. The Upper Marine conglomerates between Wallerawang and Rydal weather to a depth of about two feet, giving a fine sandy soil. On the other hand, the gravels along Piper's Flat are up to 30 feet thick, and are packed together in brown clay, especially in the type beds near Irondale. This clay is quite different from the surrounding soil, but might have been derived from weathering of granite pebbles. Be that as it may, the fact



Text-fig. 7.—Lithgow Valley, which was eroded near base-level. Note the course of Marangaroo Creek between the two monadnocks, the valley levels at 3,000 feet cut in a plateau of average elevation 3,400 feet, the entrenched meanders of the streams, and the valley divides of Marangaroo Creek.

remains that no weathered conglomerate in this district is similar to this well-defined line of gravel. There seems to be strong evidence, therefore, that these are recent stream deposits.

About two miles to the south-west of Wallerawang the Cox River plunges into a gorge, a good view of which is obtained from where the Portland Road crosses the stream. This gorge attains a maximum depth of 700 feet to the east of Rydal, and ends just above the Lett River, where it emerges from a well-defined scarp. Near Hartley the river is but little entrenched in the flat Kanimbla Valley. Below Wallerawang the stream is obsequent, a fact which is interesting when considering the past stream history. This fact bears no relationship to the silt flats along Cox's and Piper's Flat Creeks, which could not have been laid down along the present slope. Also, there is no silt in the broad valley

to the east of Wallerawang, just above where the stream flows into the higher land. An account of Solitary Creek is given when the Cox Divides are discussed.

Lithgow Valley (Text-fig. 7) is found on the same level as Wallerawang Valley, and consists of Upper Coal Measure and Upper Marine rocks, and granite. To the north rises the Blue Plateau, whilst to the south the old mountain masses of Mounts Walker and Flaherty are found. The valley is about 500 feet deep, from one to three miles wide, and is drained by Farmer's and Marangaroo Creeks. The former shows entrenched meanders along the lower part of its course, where it has cut a steep gorge, 500 feet deep, in the valley levels near the Cox junction. The divide between this stream and Marangaroo Creek to the west of Bowenfels is almost non-existent. The break in the divide is so large that the valley between Bowenfels and Marangaroo is continuous. In view of this fact it is all the more remarkable to find Marangaroo Creek flowing into the high mountain block (Text-fig. 4). The stream is certainly antecedent, and this part of Lithgow Valley is the result of differential erosion. The stream originally flowed over a plain of Hawkesbury sandstone between the two residuals. After the uplift which resulted in the formation of the Lithgow and Wallerawang levels, the stream graded a large part of its course, but could do very little lateral cutting near its mouth on account of the extreme hardness of the steeply-inclined quartzites. Further upstream, however, after cutting through the hard Hawkesbury beds, it discovered the softer Upper Coal Measure series below, and excavated a wide valley in them. A large relic of the original plateau is preserved on the 3,300 feet level to the south-east of the junction with the Cox. The upper and middle courses of Marangaroo Creek were determined by the master-joints of the Hawkesbury sandstones (i.e., in north-south, and east-west lines). The lower course was determined by the strike—about 20 degrees east of north—of the Devonian quartzites. The lower course of the creek shows deeply entrenched meanders, relics of the old plateau surface stream.

The upper course of Farmer's Creek has also been determined by joints. The lower course is old, and is mainly in softer granite and slate, avoiding the hard quartzites. Owing to the comparatively soft granite along its lower course, the stream has, unlike Marangaroo Creek, been able to prolong the upper (Lithgow) valley levels right to the Cox, although now it is deeply entrenched in them, below Bowenfels. A small plateau at 3,400 feet is found to the east of Farmer's Creek. The eastern side is a steep cliff—known as Hassan's Walls—which overlooks the Kanimbla Valley. The 3,100 feet level extends within a mile of Hartley, which is at 2,400 feet.

With regard to the idea of benching as the main cause of the valley, as suggested by Mr. Sussmilch, I have no doubt that benching is mainly responsible for the level valley above Lithgow, but has been only a minor factor in the evolution of the remainder of the valley floor.

Boyd and Budthingeroo Creeks.—The topography of the country around the heads of Kanangra River, Boyd and Budthingeroo Creeks is varied. Three series of valleys are found at various levels. Of these, the valleys of Kanangra Platform (3,300 feet) have already been described. The upper valleys of Boyd and Budthingeroo Creeks are at 3,750 and 3,950 feet respectively. They are mature in type, being more than one mile wide, and are occupied by sluggish streams flowing over swampy flats. On the traverse line they are both found at a depth of 300 feet below the plateau, which varies from 3,950 feet to the east of Boyd

Creek to 4,250 feet between the two streams, attaining a like elevation to the west of Budthingeroo Creek. Here the principal rocks are granite and slate, giving a heavy clay soil. These valleys are referable to the Lithgow and Wallerawang Valley class, and are similar to those at Oberon and Shooter's Hill.

In this vicinity, along the Tuglow-Kanangra divide, mature relic valleys at an elevation of 4,100-4,200 feet are found. These are 200 to 300 feet above the previous series, and drop steeply into the latter. These valleys are cut about a hundred feet in the soft Silurian rocks of the Jenolan Plateau, resembling the mature valleys half-way between Hampton and Jenolan, and the early mature valleys at Wentworth Falls and on the Kanangra Platform. Their present extent in this district is not great, but they appear to be relics of the Tertiary surface.

Retreat, Tuglow and Fish Rivers.—The upper valleys of these streams also belong to this series (i.e., Lithgow), although they are found at variable altitudes. The Retreat River at Porter's Retreat is 600 feet below the plateau, at 3,500 feet. The Tuglow flows in a mature valley, 300 feet below the plateau surface, which is at 4,100 feet; whilst the Fish River at Oberon flows at 3,500 feet, or 500 feet below the plateau.

These three valleys are cut in highly-inclined Silurian strata and in Devonian granites, and are, consequently, not due to any such action as benching, which was partly responsible for the formation of Lithgow Valley. They were formed under much the same conditions, as regards elevation, as the Wallerawang and Lithgow Valleys, are up to two miles wide, each having similar dimensions. One is struck by the fact that the Fish River at Oberon, which flows over marshy flats, is notably more mature than the same stream at Tarana—and, for that matter, Solitary Creek above that point—the latter valleys appearing to be of a "masked juvenile" type; that is to say, in point of age the valleys are young, but, owing to the softness of the decomposed granite in which they are cut, a stage closer to maturity has been reached than would have been the case in the somewhat harder rocks at Oberon, for example. The grades of Solitary Creek between Rydal and Tarana, and the Fish River above Tarana, towards Oberon, are not typical of mature streams, being of the average respective orders of fifty and forty-five feet to the mile. Below Tarana, the Fish River has an average grade of eleven feet per mile into Bathurst. The thalweg of the river is that of a rejuvenated stream, supporting the conclusion that the wide valley at Tarana is of recent formation, being much younger than the more mature valley at Oberon in harder rocks.

Throughout their lengths, the two branches of the Fish River show well-developed meanders, which date back either to the pre-uplift or the Lithgow Valley stage, the former being the more probable. The powerful Tuglow has cut back into the soft Silurian rocks, the head of erosion now being within three miles of the Main Divide. This short length of upland valley is, however, very mature. The Retreat River Valley shows a valley-in-valley form, the main valley at 3,500 feet being trenched to a depth of a hundred feet at Porter's Retreat. Below here, it appears to run into deeper gorges. The occurrence of a zone containing these mature valleys entrenched from three to six hundred feet in the plateau surface is very interesting. Similar valleys are found on the Middle Wollondilly and the Cookbundoon Rivers, as I hope to show in a subsequent paper, but do not occur over the main mass of the Blue Plateau, although they are found along the Wallerawang to Mudgee railway. These facts are of significance when considering the folding and warping movements which the area has undergone.

Text-fig. 8.—Megalong Valley.

Note the broad, flat floor of the valley, the great meanders of the Cox, now entrenched in the main valley floor, and the remarkably uniform increase in the depth of entrenchment of the streams from north to south. The undissected valley floor extends ten miles further northward to Hartley.

Kanimbla and Megalong Valleys.—Looking south from Mt. Walker, near Lithgow, a splendid view is obtained across the floor of the great Kanimbla Valley to Mt. Mouin, twenty-five miles away. Here, three cycles of erosion are clearly presented, which have resulted in the formation of the plateau (first level), the level Kanimbla Valley (second level), and the Cox gorges respectively. There is very clear evidence that Kanimbla Valley was formed not far above base-level.

The northern part of the valley is clearly separated from the Wallerawang levels, the respective average elevations being 2,200 and 3,100 feet. This is especially the case near Hartley, where the two—Kanimbla being here at 2,400 feet—are a little over a mile apart.

Kanimbla Valley—the southern part of which is called Megalong—extends from Hartley in the north to Mt. Mouin in the south, and from the northern cliff ramparts near Blackheath to Lowther. It has a length of twenty-five miles, a width of ten miles, and a depth of 1,100 to 1,500 feet. To the east of the Cox the valley is gently undulating; but on the western side, the valley ridges rise uniformly to the Main Divide in the vicinity of Hampton at 3,800 feet. As I have already pointed out (under the heading "Blue and Jenolan Plateau") there is very good evidence that the western side of the valley has been subjected to warping. It might be added that the uniform rise of these southern valley ridges —some of which are granite, and others Devonian rocks, both showing long outliers of Upper Marine rocks in parts—from the Kanimbla levels to the Divide is, of itself, good evidence of such warping.

The valley is thus distinctly asymmetric, but the flat northern side varies in elevation from 1,900 feet on Megalong and Blackheath Creeks to 2,600 feet between Galong and Breakfast Creeks, the average being about 2,200 feet.

The characteristic features of the valley are shown by a study of the eastern end, Megalong (see Contour Map, Text-fig. 8 and Plate xix, fig. 2). The northern and eastern confines of this valley are formed by great ramparts of Triassic sandstone, from which the softer talus rocks slope away at 18 to 20 degrees into a level valley. This valley is occupied by four main streams, Breakfast, Galong, Megalong and Pulpit Hill Creeks. The lower courses of the two former streams have cut great gorges in the valley floor, whose deepest parts are only 700 feet above the sea. They alone of the northern Kanimbla streams make accordant junctions with the Cox. Megalong and Pulpit Hill Creeks have their whole courses along the level valley, and make highly discordant junctions with the Cox. The former stream plunges down five hundred feet within a few hundred yards into the river.

The canyon which the river has cut in the relatively level valley deepens rapidly downstream. At the junction of Megalong Creek, this gorge is 800 feet deep; whereas, a little below Galong Creek, it has attained a depth of 1900 feet, the great change being due to a rapidly falling stream and a rising upper valley. A feature of the valley is the fringe of benches of Upper Marine sandstone and conglomerate on the northern and eastern sides. Much of this bench is bounded, on the outer side, by cliffs and small precipices up to eighty feet high. The main interest of the Megalong Valley lies in the series of valleys found between 1,900 and 2,300 feet (see Contour Map).

The early mature valleys at the head of Breakfast Creek and in Megalong Gap are of this series, at 2,200 feet; and occur in sandstone and conglomerate. The upper valleys of Galong Creek at 1,900 feet occur in granite, 400 feet below

the conglomerate. Between the two streams, the eastward dip of the conglomerate is of the order of a hundred feet to the mile over a range of two miles; whilst from north to south it is laid down on an undulating granite surface. Megalong and Pulpit Hill Creeks flow partly over Upper Marine rocks and partly over granite. There is little change in topography in the passage from one series to the other, and no noticeable change in stream grade. From this it is to be inferred, that differential erosion has not played a great part in the formation of the valley floor.

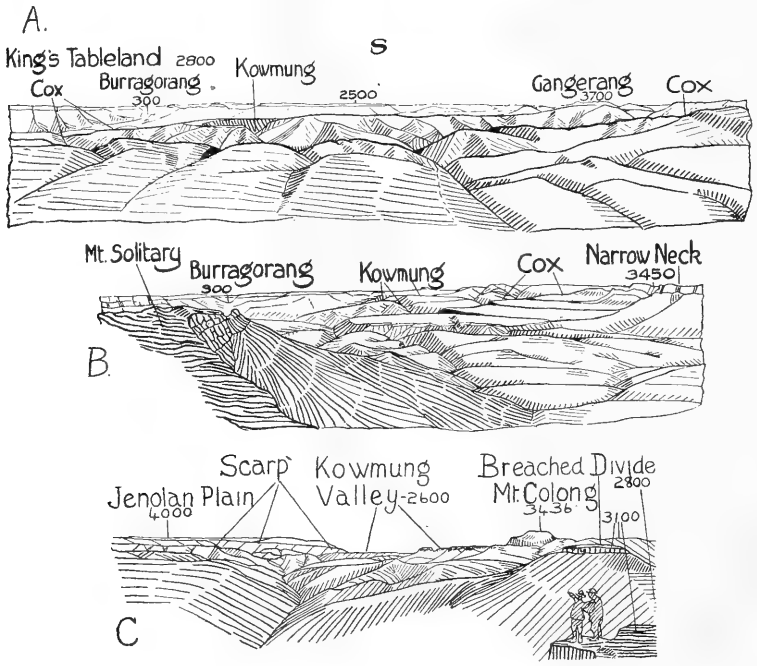
There are fairly extensive silt flats along Megalong and Pulpit Hill Creeks, consisting of flat, badly-drained silts, up to four hundred yards wide, and of some depth. These are mainly of sand; Plate xix, fig. 2, gives a typical view. These flats extend right up to the steep talus slopes, and appear to be swamp or lake deposits. They contain no stones. Obviously, these flats could not have been formed under existing conditions, as the streams are just trenching them and washing away the earth. They must have been deposited along the level valley floor before the lowest courses of the streams had their present grade, that is, before the Cox cut its deep modern gorge in the valley floor, at a time when this valley floor was near base-level.

It appears highly probable that the warping of western Kanimbla affected the valley to the east of the Cox, as the edges of these eastern ridges adjacent to the river are somewhat higher than the land a little further to the east in the valley. This is also the case with Blackheath Creek. Such warping, whether near, or a good deal above base-level before the cutting of the modern gorges, would cause the creeks to slow down, depositing part of their loads of rock waste to form these flats which are, of course, rather temporary features.

The topography of the remainder of Eastern Kanimbla is very similar to that of Megalong Valley, being, possibly, a little more subdued on account of the greater predominance of granite. The silt flats of Blackheath Creek at 2,000 feet are very extensive, whilst the valley of Lett River is very flat.

When we turn to consider the modern course of the Cox, we are struck at once by the variations in the amount of dissection going from north to south. Near Hartley, the river is entrenched only a couple of hundred feet in the level plain. At Megalong Creek the depth of entrenchment is 800 feet; whilst for twenty miles below Galong Creek the canyon of the Cox is nowhere less than 1,900 feet deep. Turning to the tributaries, the variations are still more striking. Lett River, Blackheath, Pulpit Hill and Megalong Creeks make discordant—in the latter cases highly discordant—junctions with the river. Turning to the western side, Kanangra and Jenolan Rivers make strictly accordant junctions with the Cox. Little River and Gibraltar Creek are not strictly accordant, whilst the junctions of the other streams, Cullenbenbong, Long Swamp and Lowther Creeks, for example, are discordant. The character of the gorge is clearly shown by Text-fig. 1. The effective head of erosion for the tributaries is now at the junction of Megalong Creek, although the Cox itself has cut back further. From these considerations, two definite conclusions can be drawn: firstly, Kanimbla Valley is mature, and a fairly ancient feature; secondly, the modern gorges of the Cox and its southern tributaries have been formed recently. In other words, this valley floor has only recently been raised far above base-level. Summing up, the Kanimbla Valley represents a stage, rhythm, or pause in the uplift of the plateau, of fairly long duration.

The Relationship between the Kanimbla and Wallerawang Levels.—The change from the Kanimbla to the Wallerawang levels—from Hartley to South Bowenfels—is marked by a great change in stream-valley topography. At Hartley, the Cox is little entrenched. Going up the river, however, a deep gorge is entered, which extends almost to Wallerawang, attaining a maximum depth of 600 feet near Farmer's Creek. The lower parts of Farmer's and Marangaroo Creeks have also cut deep canyons in, or, in the latter case, below the 3,100 feet level. These gorges extend some three miles up the streams, and are only just beginning to attack the soft upper valley levels. Of the twenty-four miles of river line between



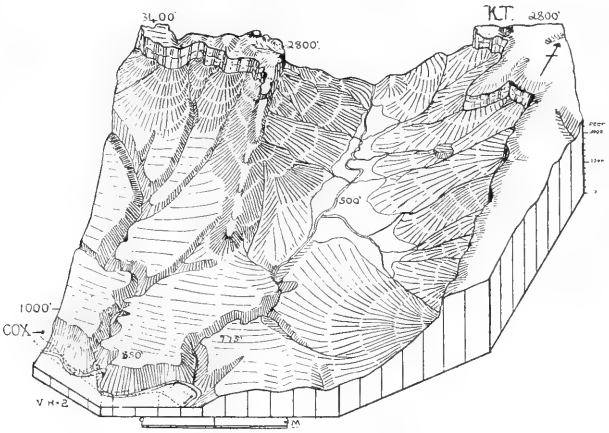
Text-fig. 9.—The warped valley of the Kowmung River.
(*a*) shows the rising warp as viewed from Mt. Mouin. (*b*) gives a view looking to the south from Mt. Solitary. In each case the warped valley floor is seen to be little dissected. (*c*) shows the old valley floor looking northwards from Bindook Swamp. Note the striking "valley-in-valley" structure, and the fault scarp to the west (left).

Hartley and the head of the Cox, only the lower thirteen miles are characterized by gorges. The junctions of these two streams with the Cox are accordant, in strong contrast to the discordant junctions of the tributary streams in the softer rocks below Hartley. The limited extent of the gorges, the steep grade of the river—forty feet per mile—and the fact that Solitary Creek runs 500 feet above the Cox, and is separated from it by an insignificant valley divide, are certain evidence that the gorges have been recently cut, with a lower limit of 2,200 feet (Hartley). That is, the Kanimbla levels have acted as a temporary base-level

of erosion for the Wallerawang levels. The physiographic fault between the two is evidence of the same thing (see Text-fig. 12).

The dissection of the higher levels has only been made possible recently by their uplift above the Kanimbla levels. That is, both the Wallerawang and Kanimbla Valley systems were formed at a constant level, and were co-extensive. Thus the upper valley once extended without a break from Piper's Flat and Wolgan Gap to Mt. Mouin. The consequences of this conclusion are fully discussed when the folding movements are considered.

Jamieson's Valley and the Kowmung Basin.—The lowlands of Jamieson's Valley are separated from the Kanimbla levels by a uniformly sloping surface, which has not been much dissected apart from the canyons of the Cox and Kowmung Rivers. The steady slope from Jamieson's Creek to Gangerang Range on the south, and Mt. Mouin on the north of the Cox, is a very striking feature. The Cox and Kowmung Rivers have cut extremely deep and narrow gorges in this surface, which vary in depth from zero at Black Hollow Creek to 2,000 feet between Mt. Mouin and Gangerang. The smaller streams flowing from the foot of Mt. Mouin are but little entrenched in this surface, although, as we have seen, the more powerful streams a little further up the Cox Valley, such as Breakfast and Kanangra Creeks, are flowing in very deep gorges similar to that of the Kowmung.



Text-fig. 10.—Lower Jamieson's Valley, showing the antecedent course of Jamieson's Creek and the stream flats due to the rise of the warp to the south-west. The warp surface is very little dissected, and rises steadily towards the south and south-west. Cedar Creek (near the western margin) is a subsequent stream. (Drawn from Contour Map.)

Jamieson's Valley is bounded on three sides by precipitous cliffs of Triassic sandstone, the open southern margin shading almost imperceptibly into the Kowmung Basin. But for the fact that the Cox River cuts across here, it would be impossible to distinguish between the two features. On the north-east, the plateau rises 2,300 feet above the valley floor, but on the south-western margin, the elevation above the tilted western margin is only about 1,000 feet (Text-fig. 9).

There are extensive silt flats along the middle portion of Jamieson's Creek in the vicinity of 500 feet (see Text-fig. 10) similar in many respects to those of

Megalong. Along Reedy Creek especially, islands rise from these flats like islands from the sea. The flats themselves are absolutely level, and consist of fine sands and clays. There are no large stones in these silts, and very few small ones. Doubtless there were some in the original deposit, but owing to the subsequent action of air and water over a fairly lengthy period, they have been disintegrated.

I am strongly of the opinion that these flats are due to the deposition of silt in a body of water. They are not due to the occupation of the valley by swamps, as peat is not found in them. Sword grass and rushes are absent, and gum trees and grass grow right to the creek. For all that, the heads of the flats are, as yet, badly drained, and are submerged in wet weather to a depth of several inches.

The origin of these flats is fairly obvious. The streams had cut down almost to base-level along their lower courses, forming a flat-bottomed valley. The edge of a warp has risen across the lower three miles of Jamieson's Creek, which was not able to keep pace in downcutting with the rise of the warp. The stream was, therefore, partially dammed, causing the formation of a lake on the upstream side, in which silt was deposited. This lake acted as a temporary base level of erosion for the Jamieson's Creek basin, and, in course of time, became almost silted up.

At the mouth of the creek, the warped surface has reached a height of 775 feet above sea-level, 275 feet above the silt flats at 500 feet. Thus the creek is antecedent. On the southern side of the Cox, at the head of the Kowmung River, the warped valley surface has attained an elevation of 2,800 feet. The lower part of Jamieson's Creek, which has a meandering course, is entrenched some 300 feet in the surface, and flows in a steep gorge cut in hard conglomerate. Headward erosion is just beginning to affect the lower margin of the flats, which have been trenched to a depth of twenty feet. The upper portion is, as yet, practically unaffected, although some terracing of the order of five feet, is shown at the junction of Reedy and Jamieson's Creeks.

The conditions of deposition appear to have been very similar to those which prevailed on the Nepean River during the deposition of the silt lakes at Wallacia and elsewhere, the general characteristics of the two deposits showing a marked similarity as regards material and stratification.

The other stream of Jamieson's Valley does not show these features, being a revived ancient stream at present having a consequent character, and is uniformly entrenched in the warped plain. In general, Jamieson's and Megalong-Kanimbla Valleys are closely related from a physiographic point of view.

The Kowmung Basin.—The topography of the Kowmung Basin is comparatively simple. In brief, the area consists of a ramp (Figs. 1, 9), which rises from 300 feet in the north-eastern corner to 2,800 feet in the south, at Bindook Swamp, and 3,000 feet near Kanangra Walls to the west. It is bounded on the east by the Tonalli Range, which varies in height above the ramp from 1,600 feet in the north to 300 feet in the extreme south, on the Wollondilly divide, the actual respective elevations of the range being 1,900 and 3,100 feet above the sea. The western edge consists of a scarp—partly valley wall, partly fault scarp—whose height above the ramp varies from 1,600 feet at Gangerang to 800 feet in the vicinity of Mt. Shivering. This surface has a remarkably uniform upward slope from the north to the south, Kiaramba Ridge, to the east of the Kowmung, being typical (Text-fig. 12*C*).

Its surface consists of Silurian, Devonian and Upper Marine rocks, and must, therefore, be a surface or plane of erosion. The streams have trenched this surface with profound juvenile gorges, up to 2,000 feet deep, but the upland form is but little altered, mature valleys being preserved right on Kiaramba Ridge. The main features of warping and past stream history are discussed under separate headings.

Jamieson's Valley and the Kowmung Basin form a great oval-shaped valley which opens in a general way into the Wollondilly Basin to the south. The outlet of the Cox is hardly noticeable in the eastern wall of this valley, being only a mile and a half wide at the top. Byrne's Gap, at the head of the Tonalli River, which is not occupied by any stream, is almost as wide. The true beginning of the "bottle-neck" constriction of the Lower Cox-Warragamba is not below the Wollondilly junction, but below the King's Tableland-Tonalli Range scarp.

At present, the 300 feet level is the base-level of erosion for the Kanimbla Valley. This latter surface continues to the east of Megalong Gap and Mt. Mouin, sloping thence uniformly, as an almost unbroken surface into Jamieson's Valley.

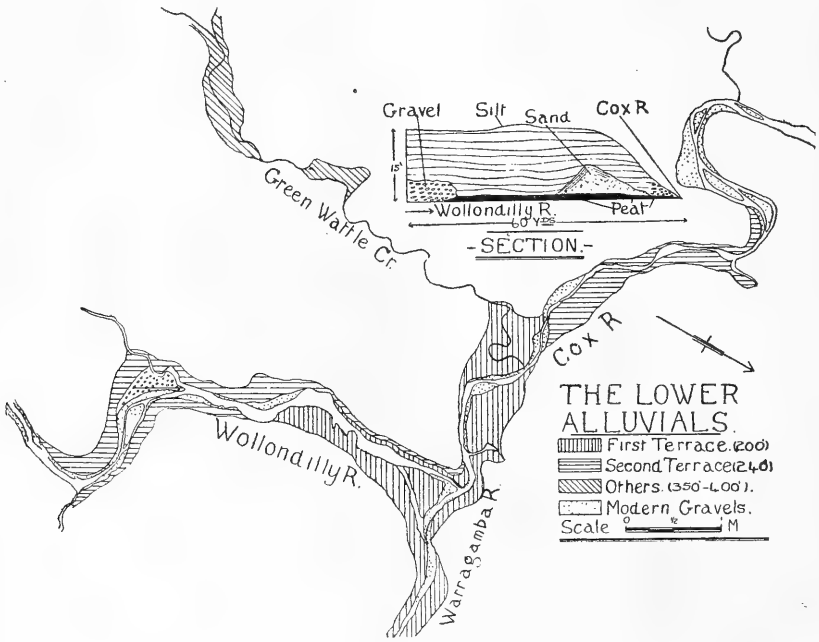
Valleys of the Lower Cox-Wollondilly.—The valleys of the Lower Cox and Wollondilly are excavated in the steps and slopes leading up to the main plateau. Here the streams have a low grade and run in deep valleys, whose depth varies from 2,000 feet in Upper Burragorang, and 1,700 feet in Lower Burragorang and the Lower Cox Valley, to 1,400 feet at the junction of the Cox and Wollondilly. The lower thirty miles of the valley of the Wollondilly are known as "Burragorang". An idea of the general appearance of these valleys is gained from Text-fig. 1 and Plate xx, fig. 2.

The Lower Cox-Wollondilly system comprises five valleys—namely Burragorang, the lower valleys of the Cox and Nattai Rivers, and those of Green Wattle and Lacy's Creeks. The average width of the Burragorang between cliff lines is somewhat less than two miles (contrast with the eight-mile-wide main Kowmung Valley). That of the Lower Cox is up to a mile and a half wide; whilst the other three vary from half to three-quarters of a mile in width. The floors of the two main valleys are flat, and consist of rich alluvial deposits up to half a mile wide, which the rivers are trenching. A typical section at the junction of the two rivers is shown in Text-fig. 11, and shows small water-worn pebbles and peat underlying horizontally-bedded silts consisting of alternate layers of roots and plant remains, and plain silt, with thin layers of peaty material. The alluvials extend up the Cox above Pearce's Creek, and up the Wollondilly above Byrne's Creek. Terracing is very noticeable at the junction of the two rivers, three terraces being found at 180, 200 and 240 feet, the second being the most important. The last-named is met with on Pearce's Creek on the Cox, and also above Fitzpatrick's Crossing on the Wollondilly, three miles above the Cox junction. Further up the Wollondilly, higher terraces are met with. At the mouth of Byrne's Creek, twenty miles above the Cox, a level detritus and silt plain occurs at 420 feet. A certain amount of uplift towards the south is very probable. The silts extend about a mile down the Warragamba, the lowest reliable level being at 150 feet above the sea, below Gogongolly Creek. The thickness of the deposits in any one place cannot be exactly determined, but the maximum is probably of the order of fifty feet at the Cox-Wollondilly junction (this is the 200 feet terrace).

These silts appear to be very similar to the silt lakes found on the Nepean at Wallacia, Penrith and Camden, and appear to have had a similar origin. In this case, a rising warp across the Warragamba caused the formation of a lake, as the

stream was not able to cut down as rapidly as the barrier was elevated. Pauses in the uplift are indicated by the formation of the root beds, when the river was able to cut down and partly drain the lake. A period of standstill is now allowing the streams to cut down and erode the deposits.

These valleys are enclosed by rampart-like cliffs of Hawkesbury sandstone, which form almost unbroken walls. Two particularly fine lengths occur, the "Burragorang Walls" and the Walls of Green Wattle Creek. The former are on the eastern side of the Wollondilly above the Nattai junction, whilst the latter



Text-fig. 11.—Silts and Terraces of the Lower Cox-Wollondilly. The section proves the nature of these silts, showing that they are old lake deposits. The peat and root beds are particularly notable. Rising terraces further to the south indicate uplift in that part.

are about five miles above the Cox junction with that stream, and also have a westward aspect. In both cases, the cliffs are quite straight, and almost unbroken, and are not even notched by tributaries. Thus they are quite different from the cliffs of the Grose and Jamieson Valleys, which are deeply cut into, even where mere wet-weather streams cross them. This absence of tributaries seems to indicate a recent formation for these streams, a conclusion supported by absence of meanders, whilst the straight and unbroken character of the cliff lines would appear to indicate a recent date for the excavation of the valleys themselves, a conclusion, as we shall see, in line with other evidence.

The course of Green Wattle Creek is interesting. Seven miles from the Cox the valley is almost a mile wide, the eastern edge being the straight walls just mentioned (Plate xx, fig. 1). The floor at 400 feet consists of sandy silts with layers of water-worn pebbles and of peaty material. The creek is slow and wide, running in a sandy channel. A mile below this point, the stream runs into a rocky

gorge, cut in a terrace of hard Permian sandstone, which is fairly extensive at 600 feet. On the stream level between three and four hundred feet, there are flat terraces up to a quarter of a mile broad, and to half a mile long, mainly on the western side at the mouth of tributary gullies. These alternate with stretches of rocky gorge cut in grey tuffs. The last mile is across the Cox Valley flats to the river, with which the creek makes an accordant junction, after wandering over the flats. The river has apparently dragged the mouth of the creek downstream.

A feature of the plateau surface in this part is the occurrence of lines of sandstone residuals, or rock hills, about two hundred feet high. One line is found along the King's Tableland; others between Black Hollow, Green Wattle, Lacy's Creeks and the Wollondilly River; and another very fine line between the Wollondilly and the Nattai (Plate xx, fig. 2). In some cases, these residuals occur right on top of the modern cliffs, and appear to have extended at one time into the area now occupied by the valleys. They are hemi-spheroidal to conical in shape, cut out of sandstone of uniform hardness, and are most likely old basalt caps or residuals from which the basalt has been removed. These lines are parallel to the Mt. Tomah-Mt. Wilson residuals. No other explanation is apparent. The residuals indicate that the older valleys (pre-uplift) in this part were a good deal narrower than the modern ones. The fact that all these valleys are of the same order of magnitude is important when considering the evolution of the stream system.

The Warragamba Gorge.—This is, perhaps, the most remarkable of all the Cox-Wollondilly canyons, not as regards depth, for its maximum depth, 1,600 feet, is only half that of Kanangra Creek Canyon, but on account of its extreme straightness. Of a course of fourteen miles between the Wollondilly-Cox junction and the Nepean, nine miles are almost perfectly straight, even the ends of the gorge being only slightly bent. Thus this stream is eminently young, and contrasts strongly with the upper and middle sections of the Cox which flow in great meanders.

For the greater part of its length the sides of the gorge are almost precipitous, the river occupying the whole width of the bottom of the gorge. Above "The Bend", three miles below the Wollondilly, the gorge widens notably, as the soft Upper Coal Measure shales, rising gradually towards the west, are exposed to the attack of the stream, which has cut terraces or benches at high flood level. The entrance from Burragorang (Taylor's "Warragamba slot") is considerably wider than a view from that valley would appear to indicate. It is actually a narrowing continuation of the Lower Cox or the Lower Burragorang Valley.

Going downstream into a narrowing canyon, sandbanks and terraces are met with until five miles below the Wollondilly. As the cliffs close in on the river, great boulders are found in the river bed, and on the hillsides up to high flood level, sixty to seventy feet above the stream. Coming to Monkey Creek the gorge, now sixteen hundred feet deep, has narrowed into a ravine. Immense boulders up to twenty feet long, fifteen feet high and ten feet wide are found by the side of the river, whose channel is, however, fairly clear. The cliffs come down steeply almost to the water's edge. Towards the lower end, within two miles of the Nepean, another change is noticed. The banks of the river are almost perpendicular, and the zone of scrub, till now so conspicuous a feature within the flood limits, is absent. This is the steepest-sided part of the canyon, although it is only three to six hundred feet deep. At the junction with the Nepean, near Wallacia, shingle beds are met with. Within the Warragamba gorge, the shingle beds extend only three miles

below the Wollondilly—an indication of the swiftness of the flood waters in this narrow track, although the average grade of the river is only seven feet per mile. The zone of scrub on either bank of the river is a most remarkable feature. There are no trees within the flood limit, but scrub, with little undergrowth, is found, with the characteristic downstream bend. Above this zone rise the forest trees, grey gum and turpentine. The scrub zone is littered with boulders and flood debris, and is almost impassable. The bottom of the gorge thus has the appearance of a lane—the river—running between footpaths which are, in turn, bordered by hedges, forest trees and cliffs.

The sides of the main gorge are indented by tributary gullies, all of which are discordant, coming in a little below high flood level. As these creeks only run in wet weather, they could hardly be expected to cut down to the normal low river level. Uplift had also something to do with the arrangement, as tiny wet-weather streams could not keep pace in downcutting with the main stream. The position of the uplift which caused the formation of the Cox-Wollondilly silt lakes is of some importance. An uplift of the order of three to five hundred feet at Wallacia partly blocked the Nepean in a similar manner. As this uplift is across the Warragamba also, and took place very recently, as is indicated later in this paper, it could readily have caused the partial blocking of the Warragamba also, and the formation of silt lakes at the head of the canyon. Recent faulting has also taken place across Monkey Creek, according to Willan.

The significance of the newly-formed Warragamba with regard to the question of past stream flow will be discussed later.

Main Folds and Warps of the Area.

The folding and warping movements which have affected the regions adjacent to the Sydney Basin have been noted by Andrews (1903) and described fully by Taylor (1923). Other contributions to the subject include Professor David's papers on the Monocline (1896) and the Kurrajong Fault (1902), and papers by Taylor, more specifically his contribution to the Pan-Pacific Guide Book (1923); Willan's "Geological Map of the Sydney Basin" (1925) is also very valuable for the area which it covers. It will be seen that the main Blue Plateau has scarcely been touched.

Surrounding the Sydney Basin, which is a neutral or "stillstand" area, there are three main lines of warping—the northern or Hawkesbury Warp, including the country between North Sydney and Broken Bay; the Blue (Mt.) Monocline fold and warp system, which extends from the north of Kurrajong, southwards to Mittagong; and the Southern Warp, or Nepean Ramp, which, beginning at Cook's River (Sydney), merges into the southern highlands in the vicinity of Moss Vale. This much is proved, but the actual uplift of the main mass of the Blue Plateau has, as yet, been a subject of conjecture. In this account, I propose to treat the Cox Basin specifically, making some reference to relevant adjacent areas.

General Considerations of the Folding.—In making a general survey of the country between the Hunter River basin and Lake George, one is struck by the regular variations of altitude. This is particularly the case near the coast, where the Sydney Basin lies between two high areas of warped country. Further to the west, in the region with which this paper deals, variations of altitude are noticeable, which can be correlated, in part, with the littoral features.

The dominant movement of uplift in the eastern portion of New South Wales has been extended along north-south lines. If it is thought that uplift took place simultaneously along the whole line, variations of altitude from place to place would be due to simple differential uplift; if the view is taken that these highlands have been built up by a system of rather localized uplifts, warp and fold lines with an east-west trend would be found, marking the northern and southern limits of each movement of uplift. Such lines of warping are found to the north and south of the Sydney Basin, and continue, as will be shown in the latter case, to the west.

The eastern Highlands of this State fall into three groups—the New England Plateau, rising to 5,500 feet; the Central, or Blue, Plateau, with a maximum elevation of 4,400 feet; and the Southern Highlands, extending from the Federal Capital Territory to Kosciusko, which have peaks over a wide area from 5,500 to 7,200 feet above the sea. The northern and central sections are separated by the Cassilis Geocol, at 2,000 feet; and the central and southern massifs by the Lake George geocol, at 2,100 to 2,300 feet. The Central is the most limited of the plateau massifs. A good deal of its elevation appears to be due to the overlapping of the main northern and southern uplifts in that section.

In dealing with the uplift of this central area included in the Cox region, the more recent earth movements have been described and located first, and the earlier folding movements identified by a process of elimination.

The Mulgoa Step.—The section of the eastern face of the monoclinal fold extending from Kurrajong Heights to Douglas Park is the result of very recent uplift. This is clearly shown by the silts of the Lower Cox-Wollondilly. Obviously the silts are of more recent age than the valleys in which they are found, these valleys, in turn, being younger than the uplift which led to their formation. The uplift responsible for the partial blocking of the Warragamba was younger than the Lower Cox-Wollondilly Valleys, and, consequently, much younger than the uplift which led to the formation of those valleys. This same uplift led to the blocking of the Nepean above Wallacia.

It is suggested that this last phase of uplift only affected the country for a limited distance behind the modern monoclinal face, over a maximum width of six miles, but generally less than that, and was responsible for these features:—

(i). Most of the uplift and faulting at Kurrajong Heights, which extends to the south across the Grose River, and across Blue Gum Creek, to the north of Springwood.

(ii). The anticline at Glenbrook, with a fault on its western side to the south-east of Glenbrook station.

(iii). Uplift at the junction of the Warragamba and Nepean Rivers, together with folding and faulting at Bent's Basin, faulting across Monkey Creek and at Razorback Range. Most of these features are clearly shown on Willan's map.

Additional proof of the recency of this uplift is given by the undissected nature of this eastern edge; even the soft shales of Kurrajong, lying on a steep slope, are practically undissected. At Mulgoa, the uplifted step to the east of the Nepean, which has undergone a general uplift of 500 feet, rising to 800 at one point, has been but little attacked by streams. To the east of The Oaks, the soft shale slopes have not been cut into much by Mt. Hunter Rivulet, but the later uplift here has only affected the country for about three miles to the west of the monoclinal face. Razorback Range, also very little cut into, may have been affected by this recent uplift.

The undissected character of this edge is in striking contrast to the amount of dissection which the streams immediately to the west have accomplished. Blue Gum Creek, to the south of the Grose is, for instance, perched on the top of the fold. A few miles to the west, Linden and Wentworth Creeks have trenched the plateau deeply right to their heads.

The western side of the Glenbrook anticline is also undissected. The river gravels scattered over the surface of Lapstone Hill, and also on the hilltops of Wallacia, are recent deposits. These loosely-cemented, or uncemented deposits cannot remain long on the hillsides, as they disintegrate rapidly, and are washed away. They cannot be compared, in point of age, with the Kanimbla Valley, or even with the lower valleys of the Cox and Wollondilly. This is significant, as no notable stream change has taken place since these gravels were elevated, which was, comparatively, very recently.

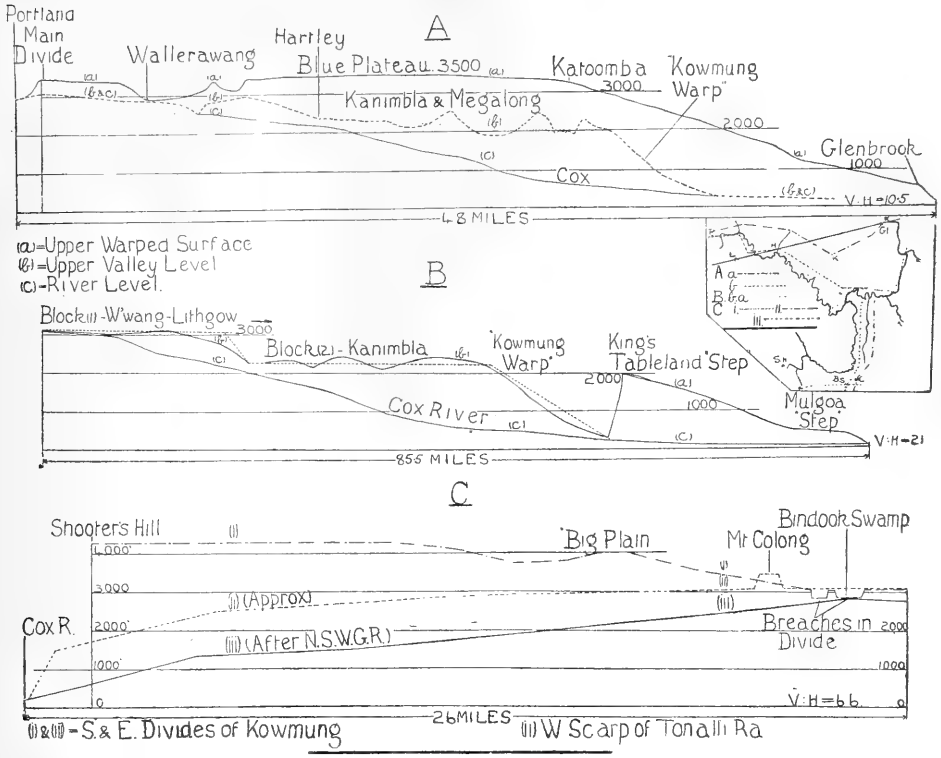
Newer Uplifts.—The Kowmung Warp.—Between the Hunter River Valley and Lake George, the age of uplift of the plateau varies regularly from north to south. The Cōlo River and its tributaries have cut great canyons in the hard Hawkesbury Series, right to their heads. The great mass of the Southern Plateau in the districts of Taralga, Moss Vale, Goulburn and the Upper Shoalhaven, is very little dissected. At Tallong, for instance, the uplands are flat and swampy. only two miles from the Shoalhaven gorge; and there are large areas of mature valleys in the Upper Wollondilly and Abercrombie basins which have no counterpart in the Grose and Colo systems. The Cox represents an intermediate stage, where the eastern section is deeply dissected, but the western part has suffered little dissection.

The idea that the southern part of these highlands has been, in general, uplifted at a more recent time than the northern part, receives striking confirmation when a detailed examination of the topography and physiography is made.

I have applied the name "Kowmung Warp" to the warping movement which is typified by the tilted plain of the main Kowmung Valley between the Cox River and the Kowmung-Wollondilly divide between Mts. Colong and Shivering. The characteristics of this surface are shown clearly in Text-fig. 9.

Two lines of evidence—geological and physiographic—go to prove that the whole surface comprised in the valley floor which stretches from Mt. Solitary in the north to the Kowmung-Wollondilly divide in the south is a warped surface. The Kowmung Valley, part only of which is occupied by the Kowmung River system, rises southwards in a gentle, almost unbroken, slope. To the west of Jamieson's Creek, a similar ramp leads up to the Kanimbla levels near Mt. Mouin, and the Gangerang Range. These slopes, which are very even, are trenched by the great gorges of the Cox and Kowmung, but these gorges occupy a relatively small part of the valley floor. This ramp, or upper valley surface, could not have been cut at its present elevation above base-level. It is clearly an old plane, or surface of erosion, which has recently been uplifted and trenched by juvenile canyons. That this uplift is recent is shown by the fact that streams rising near the base of Mt. Mouin, and flowing south and east to the Cox, have not cut down much, and are merely nibbling away the edges of the Cox gorge. The more powerful streams, such as the Cox and Kowmung Rivers, Cedar Creek and, to the west, Breakfast and Kanangra Creeks, have graded their channels, but still flow in extremely narrow gorges. Black Hollow Creek is not much entrenched in the surface, and the shale beds leading down from Kiaramba Ridge to the Cox near Black Hollow Creek are almost undissected.

The evidence offered by Jamieson's Creek very definitely confirms this idea of warping, and is of the utmost value as a positive proof of the nature and recency of the warping. The relationship of the valleys to the tilted plain is clearly shown in Text-fig. 12. Thus Kanimbla-Megalong Valley bears the same relationship to Jamieson's Valley as the Wallerawang levels bear to the Kanimbla. In either case a flexure separates the valleys. The other evidence in the matter is more geological in character.



Text-fig. 12.—The Relationship between the Plateaux and Valleys of the Area. (A) shows the parallelism of the valley levels of the Cox with the plateau surface. Comparison is possible by projecting the two section lines of unequal lengths (broken lines) on to a straight line of uniform direction, thus giving the components of the various slopes, and hence the amount of folding in the given direction. (B) shows the two flexures in the former co-extensive valley levels, and their influence on the grade of the Cox River. (C) illustrates the effect of the Kowmung Warp on the plateau and the valley floor, and the rise up to the high Jenolan Plateau from the Blue Plateau level. Graph (i) is perpendicular to (ii) and (iii), and intersects them at Bindook Swamp. These figures constitute a deductive proof of the folding theories of this paper.

The deformation due to late warping is clearly shown by the Upper Marine sandstones between Jamieson's Creek and Mt. Mouin. These beds rise at the rate of 280 feet to the mile into Megalong Gap, and present an almost unbroken surface, very similar to that of the Hawkesbury sandstones of the Blue Plateau. An area of relative depression exists between the foot of the Mt. Solitary talus and Mt. Mouin (Text-fig. 9*B*) to the south-west. Here there is a marked change in the

slope of the sandstone. To the east, and under Mt. Solitary, the beds are sub-horizontal; to the west, they rise at the rate of 280 feet per mile—a slope far greater than that of the corresponding part of the Blue Plateau between Wentworth Falls and the Marked Tree (beyond Katoomba) which is of the order of 130 feet per mile, or the 170 feet to the mile rise of the Upper Coal Measures between Woodford and Katoomba. These, it may be noted, are maximum slopes. To the north of Megalong Gap, the series is sub-horizontal to Hartley, to the north of which there is a step up of the order of 500 feet to the Lithgow-Wallerawang levels. Cedar Creek, to the south-west of Mt. Solitary, flows along the north-eastern margin of the steep slope leading up to Mt. Mouin and its slight, uniform gradient in a gorge up to 600 feet deep, distinguishes it from Jamieson's Creek, the mouth of which only has been affected by the warping (Text-fig. 12*A*).

It is highly probable that the bedding planes of the sandstones are not parallel to the general warped surface, since the thickness of the beds varies considerably within small areas, the warped surface of erosion in such parts apparently cutting across the bedding planes. This variation is well marked to the west of Jamieson's Creek. At the junction of this stream with the Cox, the Upper Marine beds have a thickness of 300-400 feet. Below Cedar Creek, the river flows through a breached anticline of intensely hard metamorphic Devonian rock which here outcrops on the warped slope on either side of the river, being obscured to the east and west, away from the stream, by the newer sandstone. Still further up the river, the sandstones form a capping, up to 200 feet thick, on the highly-inclined Devonian beds. A notable thickening to a maximum of 450 feet is observed in the neighbourhood of Megalong Gap and Mt. Mouin. Three miles north of the Gap, on the same level, granite is exposed on the valley floor, capped in places with a thin layer of sandstone and conglomerate. Again, erosion appears to have taken place across the bedding planes.

These Upper Marine beds are found right along Kiaramba Ridge, on the eastern side of the Kowmung River, and outcrop near Mt. Colong, on part of the Kowmung-Wollondilly divide. Towards the head of the main Kowmung Valley, highly-inclined Silurian rocks, which contain the Colong Caves, outcrop on the upper valley floor, and their bevelled edges form part of the general warp slope. Other ridges on the western side of the Kowmung—Gingra, for instance, which leads down from Kanangra Walls—are level benches, part of this valley being cut in tilted Devonian strata. Near the junction of the Kowmung and Cox, the tilted surface is prominent on both sides of the Kowmung.

This main valley, eight miles wide, is hardly scarred by Black Hollow Creek, but the great canyon of the Kowmung is prominent. After passing the gap in the Cox divide near the end of Kiaramba Ridge, which is only 800 feet above the Cox, the river pursues an antecedent course, flowing into the highlands, and joining the Cox in an upstream direction in a gorge 2,000 feet deep. The gradual slope down to the Cox on the east of this part of the Kowmung Valley is unbroken by large gullies, although it consists largely of soft shales. There are also relics of mature valleys on the Kowmung-Wollondilly divide which are treated later. In passing, it may be noted that Byrne's Gap, to the east of Mt. Colong, may once have been occupied by a stream flowing northwards from the present Tonalli River area into the Kowmung.

An assumption that these great valleys were formed as a result of differential erosion in hard and soft strata is not justifiable, not only on account of the

evidence given above, but also because it would imply that weak streams, such as Black Hollow Creek, were capable of great lateral erosion after rejuvenation, but before doing much down cutting; and also because the rocks which were eroded to form this valley were hard, being Hawkesbury sandstones, Upper Coal Measure and Upper Marine Series, which were all littoral deposits. The really soft rocks of the area lie on the Kowmung-Wollondilly divide, between Bindook Swamp and Mt. Werong, which are highland areas. It is interesting to note that similar theories of sharp local warping are being advocated by Mr. Sussmilch for the Upper Hunter basin.

The Extent and External Relationships of the Kowmung Warp.—So far, field evidence has been advanced which has shown, *inter alia*, that Wallerawang, Kanimbla, Megalong, Jamieson's and the Kowmung Valleys were once coextensive and have been subjected to differential uplift, so that they are now separated by sharp flexures. It is possible to correlate these valley levels, and the earth movements producing them, with the levels and movements which produced the present Blue Plateau. Text-fig. 12*A*, which is based on simple mathematical projection of broken lines on a fixed line—the latter joining Glenbrook and Mt. Lambie, and running in a W.N.W. and E.S.E. direction—shows the relationship between the two. Each curve gives the component of the slope along fixed lines in the constant direction, and thus shows the folding movements of each line in that direction, which latter is generally taken to be the average slope of the Blue Plateau Monocline, and is certainly perpendicular to the Kurrajong-Glenbrook-Mittagong fold.

Proceeding eastwards from the Main Divide it is seen that the Piper's Flat-Wallerawang Valley is subparallel to the plateau surface, the latter being intersected by the valley of Cox's Creek. A kink in the plateau surface corresponds to a kink in the valley curve, and indicates a relative downthrow area. The Hartley flexure has no exact counterpart on the plateau surface, although the high ridges at Clarence (not shown) are possibly related. The Kanimbla-Megalong levels are parallel to the main plateau. The curve of the Kowmung Warp between Mt. Mouin and Jamieson's Creek is distinctly related to the curve of the plateau between Woodford and Katoomba. Below Jamieson's Creek the old distinctive valley levels end. It is seen that the profiles of the upper valley levels and of the plateau are distinctly sympathetic. When one considers that the warping and faulting of the Jenolan Plateau have taken place not far to the west of these valleys, the correlation is still more striking. Obviously, the earth movements which produced the flexures in the valley floor also affected the plateau surface, or, in other words, since the curves show such a striking sympathy of contour, they were produced by the same earth movements; that is, the valley levels are older than the more recent flexing movements. The nature of the original folds which produced the surface in which the valleys were originally incised will be shown later.

This piece of correlation also throws light on the extent of the Kowmung Warp, since this warp is clearly shown on the present plateau surface, the eastern edge extending across the country between Katoomba and Wentworth Falls, by Mts. Hay, Tomah and Irvine, and apparently dying out gradually to the north. A definite scarp exists along this line. One result of this is to give Katoomba an average annual rainfall of 56 inches, whereas, without the scarp, the rainfall would probably not exceed 40 inches.

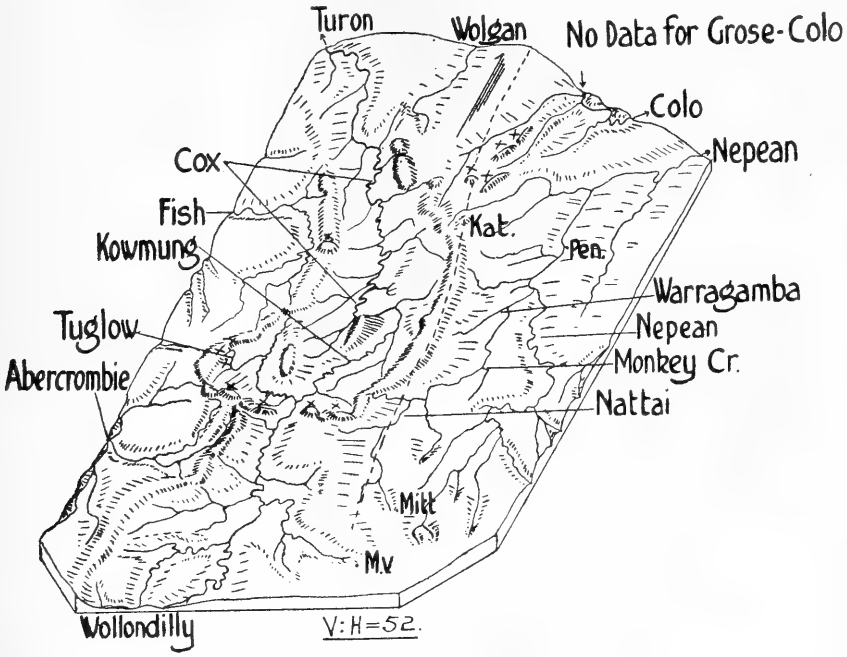
The warping may also be correlated with the Nepean Ramp, extending southwards from the neighbourhood of Sydney towards the Shoalhaven River. The edge of this warp is not perpendicular to the general north-south line of the monocline, but runs to the south-west from (near) Sydney to Picton, where the Razorback Range, at the point where this warp crosses the monocline, is probably a fault block.

To the north-west, the hinge is somewhat indefinite towards Oakdale, owing to the flattening of the warp and great erosion in the soft shales by tributaries of the Nepean, but the southern rise is plainly shown on both sides of the Burragorang Valley. To the west of Burragorang, the uplift appears to have been more intense, as the plateau to the west at 3,100 feet is 600 feet higher than the plateau to the east of this valley at 2,500 feet. It is extremely probable that this part of the valley of the Wollondilly has been excavated along a fault line, the valleys of Lacy's and Green Wattle Creeks probably following smaller faults. I hope to discuss this matter fully in a future paper on the Wollondilly Basin.

On the east of Burragorang, there is a rise of 400 feet on the plateau from the Warragamba to the Nattai Valley, a distance of seven miles. To the west, the long ridges between the Wollondilly and Black Hollow Creek rise from 1,900 feet in the vicinity of the Cox to an average of 3,100 feet on the plateau around Mt. Colong over a distance of nineteen miles (Text-fig. 12*C*), giving an average slope of 63 feet per mile. The rise of Kiaramba Ridge from the Cox to Bindook Swamp on the Kowmung-Wollondilly divide is 2,500 feet (all of which is not due to warping, although most is) over a distance of 23 miles, giving an average slope of the order of 119 feet per mile. Thus there is a regular change of slope along the lines perpendicular to the edge of the warp as one moves from the east of Burragorang to the north of Jamieson's Creek. The average mean slopes are of the order, in feet per mile, of: Plateau from the Warragamba to the Nattai, 59; plateau between the Cox and Bindook Creek, 63 (Text-fig. 12*C*); Kiaramba Ridge in the Kowmung Valley, 109; upper valley slope from Jamieson's Creek to Megalong Gap, 280; plateau between Wentworth Falls and Katoomba, 140 feet. It will thus be seen that the warping reached a maximum of intensity to the north-east of Gangerang Range. To the west and south-west of Gangerang, the movement of uplift became so intense that faulting took place, as we have seen in the study of the Kanangra Platform. The Nepean Ramp-Kowmung Warp thus has the general form of a plunging syncline. It will be noted that the greatest thickness of Permian and Triassic rocks lies at the focus of the northern edge of this syncline; that is, the old Permian and Triassic geosyncline has been revived and intensified by late warping movements.

The latest uplift of Jenolan Plateau, which differentiates it from the main Blue Plateau, has already been discussed. A well-marked warp runs from the western side of Mt. Lambie to the north of Rydal, and thence on the western side of Kanimbla Valley between the Cox River and the main Divide. This warp has also affected the eastern part of Megalong Valley to the south of Megalong Creek. Still further south, it passes into a fault, which begins near the junction of the Cox and Kanangra Rivers and runs parallel to the latter. Indeed, the course of this stream and its great canyon have been determined by this fault. Continuing to the south of Kanangra Walls, the fault becomes indistinct in the soft rocks of the Kowmung-Wollondilly divide, but appears to continue into the Wollondilly Basin, and to be connected with the Lake George fault system. I hope to discuss this matter in a later paper.

The physiographic fault at Hartley is, I think, not nearly so extensive as this other fault on the west of the Kowmung. Apparently the main warp some five miles to the north of Hampton bifurcates, one branch continuing in a less intense form to the north, towards Mt. Lambie, the other branch going to the north-east across the mouth of Lowther Creek, where it is probably responsible for Blaxland's Swamp, and continuing to the west of Hartley, and for some distance to the north of the high ridge at Mt. Clarence (up to 4,000 feet). The kink in the plateau and upper valley surfaces near Lithgow appears to be a part of this earth ripple. In the foregoing discussion, the existence of older folds has been kept in the background. Having determined and localized the newer earth movements, it is now possible to identify the older folds.



Text-fig. 13.—Pre-uplift Peneplain Surface.

Primitive folds and basalt residuals are found in meridional lines, with a different stream arrangement from that obtaining at the present time. The broken line shows the crest of the first extensive fold, which was an anticline.

The Old Blue (Mt.) Anticline.—The existence of a monoclinal fold in the vicinity of Kurrajong and Glenbrook was proved by David. At Kurrajong Heights, a maximum vertical displacement of 1,900 feet has been caused by folding and faulting. Near Glenbrook, the amount of uplift varies from 600 to 800 feet. As the fold between Kurrajong Heights and Bent's Basin is composed of hard sandstone, and is of recent formation, it is well preserved. That this fold continues to the south is clearly shown by sections of Wianamatta shale near The Oaks and at Mowbray Park, between Picton and the Nattai River. To the west, the shale is sub-horizontal, but it dips sharply to the east on to the flat country near Camden and the more elevated land in the vicinity of Picton.

To the south of Picton and the west of the Nepean River there is a definite dip of the land surface to the east, as the railway heights indicate. The more easterly new line through Bargo is, on the average, 150 feet lower than the older line to the west, through Picton Lakes and Balmoral. At Mittagong, the monoclinal fold again appears to be present, rising 500 feet above the plain. Mt. Alexander, to the north of the town, is composed of sandstones which dip to the south at an angle of 11°, according to Taylor. This dip would be sufficient to account for the vertical displacement of 500 feet without faulting, although it is probable that both folding and faulting are involved. Still further to the south, the monocline as a distinctive topographic feature appears to die out. The southern portion of the fold is superimposed on the Kowmung Warp and the Nepean Ramp. It has already been shown that, between Picton and Kurrajong Heights, the face of this monocline is of recent development. The old eastern face of the main Blue Plateau uplifts was from three to six miles to the west, and the fold had a much more uniform slope at its base, as the Mulgoa Step had not been formed. From Razorback southwards, however, it is probable that the original fold face is preserved. The nature and extent of the first folding movement may be determined by subtracting the later movements from the sum total. This is readily done by reducing the Kowmung-Kanimbla-Wallerawang Valleys to their original level. We have already seen that all of these valley floors were, in the past, co-extensive. By flattening out the later flexures, therefore, the original contour of what is now the plateau surface will be obtained, as in Text-fig. 14.

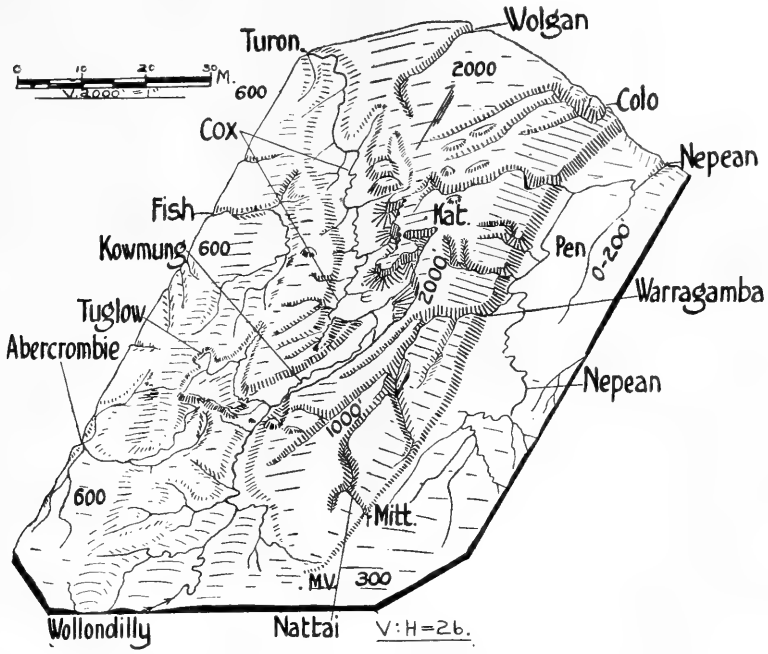
At Wallerawang, the plateau surface was 600 feet above the local base-level of erosion (*not* 600 feet above sea-level); Kanimbla Valley was entrenched 1,200 feet in the plateau surface, Jamieson's Valley, 1,500 feet, and the Kowmung Valley from 1,400 feet at the Cox junction to 400 feet at Bindook Swamp. Thus the surface takes the form of an asymmetric anticline (Text-fig. 14), with a steep eastern limb and a gently sloping western limb. It attained a maximum elevation of 2,000 feet along the Bilpin-Hazelbrook-King's Tableland line, which step continued across the present Lower Cox Valley, and is still found to the east of Burragorang Valley.

If a hinge or line of folding were developed along some part of an asymmetric anticline, near the crest, and the limb of the original fold away from the hinge and the crest were uplifted, then that part of the fold adjacent to the original crest of the anticline, and along the new hinge, would be rather flattened, that is, its curvature would be decreased. That is to say, there would be a change of slope—or "step"—in the final fold curve near the position of the crest of the original anticline.

That such a position has arisen in this region is shown by the topography of the plateau surface. The land near the crest of the old anticlinal fold is now represented by the Bilpin-Hazelbrook-King's Tableland step at 2,200 feet. That this step was the crest of the old fold is clearly shown by the decreasing depth of the upper valleys as one goes to the west (Text-fig. 12), and by the still-existing uniform slope to the east. This theory has four specific advantages:—

1. It explains the erosion of the great Jamieson's Valley almost to the Grose Divide, and the formation of the Lower Cox and the Burragorang Valleys. All of these are located on, or near, the supposed anticlinal crest, which would be the main line of weakness and erosion. The continuous and almost straight line of these valleys is most striking. It is also notable that the Kowmung Valley is not included in this system.

2. It also explains the peculiar topography of the King's Tableland, which can only be mentioned briefly here. A number of small streams rise on this step and flow westwards into Jamieson's Valley, rising in broad, swampy mature valleys between 1,800 and 2,000 feet. They plunge into the higher land from



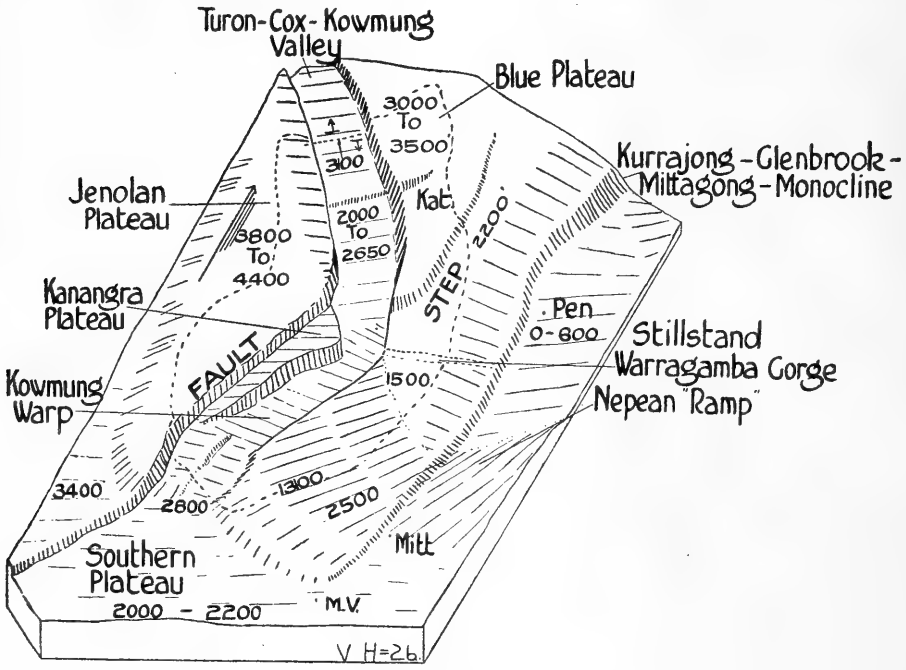
Text-fig. 14.—The Old Blue Mountain Anticline.
The old anticline had a steep eastern face, but sloped gently to the west. The heights given *are above the local base levels of the respective districts.* The elevation of the western portion (marked 600 feet) was probably of the order of 1,000 feet above modern sea-level. The central heights are approximately correct on both standards, as are the eastern.

2,200 to 2,300 feet before entering the valley, flowing through narrow little gorges. They appear to be antecedent, and their swamps may have formed by the partial blocking of the streams caused by a slowly-rising barrier to the west—the newer fold, or Kowmung Warp. I hope to discuss this more fully in a future short paper.

3. The formation of the Nattai Valley is explained. At the present time the Nattai is a misfit, trickling over the floor of a big valley. The cliff walls are much cut up and dissected, in strong contrast to the straight, new cliffs of Burragorang. As the Nattai shows small meanders such as are not found on the lower Wollondilly, its valley is also older. This agrees with the previous conclusion that the latter is a recently-formed stream, its position being determined by the location of the old anticlinal crest. This point will be further discussed later.

4. Such a fold as is postulated in Text-fig. 14 accounts for the very extensive dissection of the hard rocks which has been accomplished by Erskine, Glenbrook and Euroka Creeks, the Grose River and its tributaries, the Colo system and the

Nattai. The country which was more affected by the later warping and folding, although now more elevated, has not suffered anything like the same degree of dissection. Again, the newly-raised Nepean Ramp and the Southern Tablelands around Goulburn are comparatively little dissected. In general, the mature valley systems (Kanimbla, etc.), which have been described, fit in very well with this theory.



Text-fig. 15.—Analysis of the Fold Systems (generalized).

The principal modern tectonic features of the region are here summarized. Overlapping of folds gives greater elevation, so the most elevated part (Jenolan Plateau) has undergone three uplifts. The superposition of the old anticline on the Kowmung Warp, and its effect on the altitude of that part of the region are shown. This is an extension and generalization of Text-fig. 2.
Scale: 1 inch = 30 miles. Cox divide shown thus - - - - - -.

Text-figs. 13, 14 and 15 show the whole process of folding which the Cox Basin has undergone. Text-fig. 13 is further discussed later. Text-fig. 14 is a restoration of the old anticline, based on the data shown in Text-fig. 12, whilst Text-fig. 15 shows the principal modern features of the topography, and summarizes the conclusions as to the nature of the post-basaltic earth movements which have affected this area. The northern edge of the warping and folding movements which uplifted the southern highlands of this State is represented by the Kowmung Warp. The southern edge of the main northern uplift is represented by the Hornsby Warp across the Hawkesbury, and the old anticline.

Direction of Forces Causing Uplift.—Whilst it is very unsafe to base any very general conclusions as to the direction of forces causing these uplifts on the evidence offered here alone, a few suggestions might not be out of place. There

is, I think, very little evidence to justify the possible suggestion that the uplift of this region is largely the result of purely compressive (tangential) forces. On account of the general low angular value of the warping movements, the absence of great overthrust faults, and the formation of purely plateau topography, the forces of uplift would appear to have been, in the main, normal to the surface of the earth. This would involve a certain amount of compression, as two normal forces at different points would give rise to a certain resultant tangential force. It has been suggested that the uplift of this plateau was the result of forces acting from the Pacific. Alternatively, another opinion has been expressed that the later phases of uplift were largely caused by forces from the west. A tentative conclusion might be, that the principal uplifts were the result of normal forces, and the tangential forces which they set up acted mainly from the west, although forces acting from the east were not unknown.

Streams of the Area.

Stream Characteristics and Relationships.—The general characteristics of the streams of Eastern Australia have been outlined by Taylor (Physiography of E. Australia), who has discussed many specific anomalies of flow. These streams fall into two main classes—longitudinal and transverse. The first class includes many of the tributaries of the Upper Murrumbidgee, the greater part of the Wollondilly, Shoalhaven and Nepean, the Upper Cox and some streams of the Upper Hunter. Such streams as the lower parts of the Clyde, Shoalhaven and Hawkesbury, the Upper Abercrombie and Turon, the Grose, Colo, Goulburn and Lower Hunter Rivers may all be classed as transverse streams. In general, each main river system includes many streams of each type, but the highly irregular, meandering courses throughout their lengths of the composite rivers give evidence that the present anomalous arrangement is, in general, of some age.

In the Cox Basin itself the streams fall naturally into two classes, according to geographic distribution. Those in the western part of the area, such as the Cox above Jamieson's Creek, the Kowmung, Tuglow, Upper Wollondilly Rivers and many smaller streams flow in highly irregular meandering courses (Text-figs. 4 and 8), although, for the most part, they are now entrenched in deep canyons. These meanders have been inherited from earlier cycles. The eastern streams, such as the Lower Wollondilly, Warragamba, Lower Cox and, a little to the north, Erskine Creek and Grose River, do not show meanders. They are generally straight, with bends and curves of low angular value. In fact the main river—the Warragamba—is absolutely straight for nine miles of its fifteen-mile course. These streams are quite different from, and of much more recent formation than, those of the first-mentioned class, which show structural affinities with the ancient rivers of the Western Slopes, the Macquarie and Abercrombie. On these grounds one might reasonably believe that the Western Cox Basin once belonged to the Western stream system.

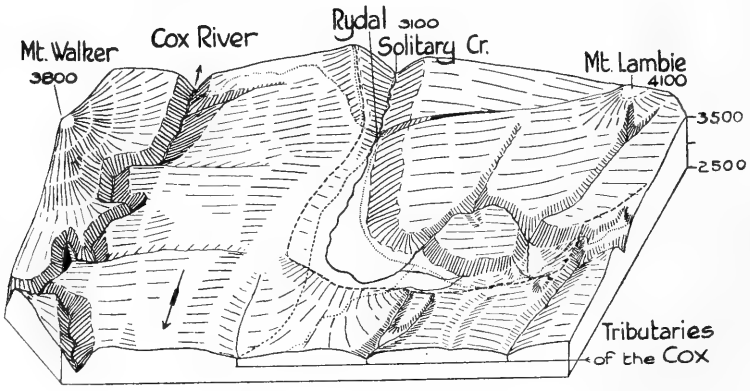
The Cox River Basin occupies an oval-shaped area at the centre of a radial drainage system. Many of the main streams of east-central New South Wales rise on the Cox watershed. They include the Grose and Colo Rivers, the Turon, Campbell and Fish Rivers of the Macquarie system, the Abercrombie River, and tributaries of the Wollondilly and Nepean. At first glance it might be thought that the Cox is a simple consequent stream, whose origin is directly traceable to the uplift of the Blue Plateau and which has eroded its present complicated series of canyons directly in that surface, enlarging itself at the expense of surrounding

streams. Field evidence is quite against this, as the Upper Cox itself is threatened with capture in places, and that part of its basin is in a state of siege.

Divides of the Cox.—In places where the original plateau surface is well preserved, such as Katoomba, Hampton, Shooter's Hill, and King's Tableland, the divide is comparatively wide and flat. It is the remains of an ancient peneplain, dissected to a depth of 200 feet by mature valleys, the direction of short streams being largely determined by local geological structure. To the north and north-east of Lithgow, for example, the influence of two perpendicular sets of master joints has given the streams a trellis pattern. The small cores of undissected country on the eastern and southern divides are being attacked by steep streams on either side of the watershed. At some places local captures are pending, as Wentworth Falls (Taylor), and also near Mt. Werong, where Werong Creek, of the Kowmung system, has captured part of the head of the Abercrombie on an ancient plain.

The Main Divide between Rydal and Jenolan is a high ridge flanked on either side by sub-mature valleys. Here there is no prospect of any marked stream readjustment.

In other places the divide is very unstable. At Wolgan Gap it has been breached, and Cox's Creek rises above a yawning valley in which the Wolgan River flows, 1,200 feet below. Capture of the high stream has proceeded to some



Text-fig. 16.—Solitary Creek.

Note the high-level valley of the Creek, and the steep canyon of the Cox. The high-level valley of the Cox between Rydal and Mt. Walker is shown, and the meanders of the Cox. Solitary Creek is on the point of capture. Note the small antecedent tributary on the west in the diagram. Scale: 1 inch = 2 miles.

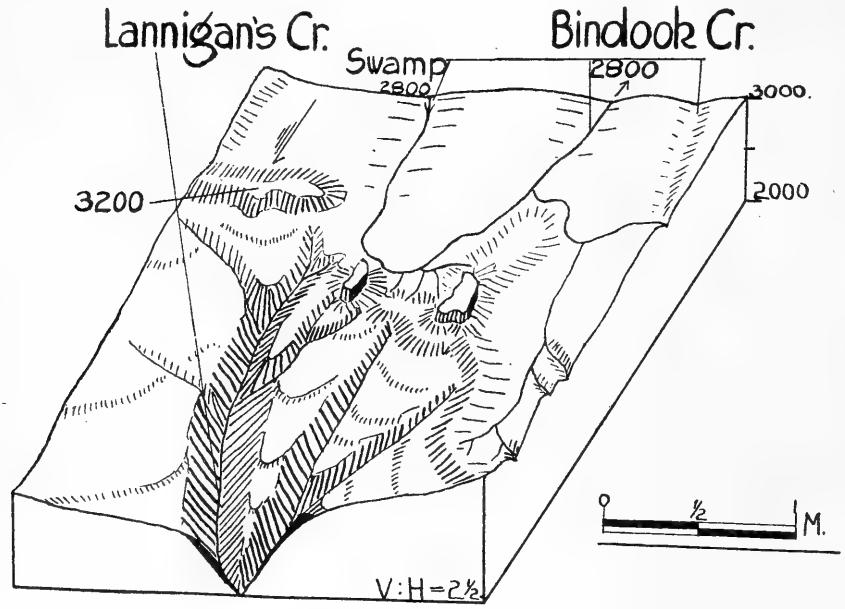
extent. Again, at Piper's Flat the Main Divide is represented by a ridge which rises forty feet above the plain, and is about a quarter of a mile wide. This runs across a valley four miles wide and 400 feet deep, and appears to be a local fold in shale. On the northern side Dulhunty's Creek, a tributary of Williewa Creek (Turon), is flowing at a lower level than Piper's Flat Creek, and with a steeper grade—100 feet per mile as against 30 feet. It is cutting back in the soft ridge, and threatening to capture Piper's Flat Creek. A few miles to the north the head of Gow's Creek, flowing in a broad valley at 3,500 feet, is being captured by a

small tributary of Solitary Creek. Here a slight change only is involved. Two great breaches in the western divides, at Rydal and Bindook Swamp, call for special attention.

Solitary Creek.—Solitary Creek (Text-figs. 4 and 16) rises on the northern side of Mt. Lambie and, turning, flows southwards through Rydal and later, with the Fish River, pursues a westward course through Bathurst, thus forming part of a spiral. Between the Lambie block and Mt. Walker the upper valley surface of the Cox is prominent at 3,100 feet, stretching south to the scarp near Hartley. Immediately to the south-west of Solitary Creek Plain between Wallerawang and Rydal, a continuous scarp rises, which is a continuation of the Western Kanimbla Warp. A small tributary of Solitary Creek flows into the warp (right centre, Text-fig. 16), whilst a little lower down Solitary Creek flows across the warp line on to a plain, re-entering the higher scarp just above Rydal. Six hundred feet below, and only two miles away, the Cox flows in a juvenile gorge sawn in tremendously hard quartzite, whilst steep tributaries are threatening to capture Solitary Creek from the east and north. Immediately to the north of Rydal the Main Divide is only half a mile from the creek, and fifteen feet above it, the valley, along which the Western Railway runs, being quite continuous. The Cox shows very fine meanders in extremely hard rock, and so must have followed its present course before the cutting of its modern trench. On the other hand, it is not possible that Solitary Creek should have maintained its present relative course for long, since tributaries of Piper's Flat Creek, but slightly rejuvenated, are in the course of capturing it. The presence of the continuous Wallerawang-Rydal Valley and the boathook bend of Solitary Creek, together with the age and power of the main river, show that some stream change has taken place. A reconstruction of the topography when the Wallerawang and Kanimbla levels were co-extensive is instructive. Then the Cox flowed sluggishly over the plain floor of its valley. The local "kink" in the valley floor and the plateau near Wallerawang (Text-fig. 12) could not then have existed, as it is lower in the valley than the contemporaneous valley levels on all sides at 3,000 to 3,200 feet. At that time Solitary and Piper's Flat Creeks, and the Main Divide at Piper's Flat were on much the same level. Later, probably in conjunction with the fault at Hartley, the area around Wallerawang lagged behind a little in the continuous uplift, forming a small tectonic hollow. Uplift and tilting of the Wallerawang Valley took place towards the west and south-west. Piper's Flat now has a grade of 30 feet per mile, and is being eroded. Experience shows that streams—e.g., the Lower Cox and Wollondilly—erode previously deposited alluvials when flowing at a grade of only ten feet per mile. Piper's Flat, now being eroded, could not have been formed at its present slope. At the same time, the Cox could not have readily captured Solitary Creek, as it had not then its present advantage of grade. But to suppose that Solitary Creek at that time flowed as it does now, leaves unexplained the great Wallerawang-Rydal Valley, which is quite dissimilar to other valleys of tributary streams just to the west, and has been carved in hard conglomerate and quartzite by stream action. Also, the anomalies of the present Main Divide—here partly valley, partly slope divide—are not explained.

On account of the permanence of the Cox, one is forced to the conclusion that a stream once occupied Wallerawang-Rydal Valley, and flowed from Rydal to the Cox. This would place the Main Divide near Tarana, and might include Antonio's Creek, which runs northward into Solitary Creek and parallel to the Main Divide, in the Cox system. This old Divide would have passed in a normal

manner over Mt. Lambie, and would have consisted of very soft, decomposed granite, similar to that at Sodwalls. After the inception of the present topography, but before the sagging around Wallerawang, the Fish River and its tributaries, tearing back through the soft granite, captured Solitary Creek near Tarana. Then the Cox, being rejuvenated in this part, cut back past Mt. Walker, and the slight sagging around Wallerawang gave the small tributaries of Piper's Flat Creek a higher grade than previously, so that now Solitary Creek, entrenching slowly, is threatened with recapture by the Cox. The thalweg of Solitary Creek below Rydal supports this theory. The head of entrenchment is at Rydal. The grade from here to Tarana (12 miles) is 50 feet per mile, whilst from Tarana to Bathurst, Fish River has only a grade of 11 feet per mile. The steepest portion, between Rydal and Sodwalls, just above Antonio's Creek, has a grade of 70 feet



Text-fig. 17.—The Breached Divide at Bindook Swamp.
Lannigan's Creek is on the point of capturing the high-level swamps. Note the erratic course of Bindook Creek, and the sandstone residuals in a late mature valley.

per mile. Considering these figures, and the softness of the decomposed granite, one concludes that the tributary of Fish River, flowing at a low level, was quite competent to capture Solitary Creek from the Cox when the latter was at a standstill. Rejuvenation has since moved upstream from the supposed ancient divide. Thus Cox River is now about to recapture Solitary Creek.

Bindook Swamp.—Bindook Swamp lies on the Kowmung-Wollondilly divide four miles south-west of Mt. Colong. The swamp lies in a great level valley, 2,800 feet above the sea, to the east and west of which the plateau rises to an elevation of 3,200 feet, and is cut in sandstone (horizontal) and slate (Text-fig. 17). Two isolated sandstone hills are left in the valley, which is cut in very soft Silurian

strata. Bindook Creek flows north over a level valley to within a couple of hundred yards of the divide, which is only a few feet above the stream and is absolutely flat. It then turns south, and flows to the Wollondilly. This condition of affairs is obviously transient, as Lannigan's Creek is on the point of capturing Bindook Creek. The gap in the divide is three-quarters of a mile wide, and the valley of which it is part is mature to late mature in type. It forms a link between the Kowmung Valley on the north and the Wollondilly Valley on the south. It represents at present an air gap in the divide formed by stream erosion. The relationship of this to the Kowmung and Wollondilly is discussed later.

Cox River and its Tributaries.

Relative Stream Ages.—The general classification of streams into a newer and an older type has already been mentioned. This classification would, however, fall to the ground if ancient streams following meandering courses were to assume meandering courses subsequent to uplift and rejuvenation. But such ancient streams will continue to enlarge their meanders after rejuvenation, as tangential horizontal forces still act at the bends, eroding on the convex stream bends and causing the channel to migrate. Fine examples of these meanders enlarged by a revived stream flowing down a warp are observed on the Cox near Jamieson's Creek. The long straight courses of the Lower Wollondilly and the Warragamba especially, which are consequent streams, and the straight character of their gorges, with a slight overlapping of spurs, indicate that they are certainly newly-formed streams. Many similarly revived streams in this region—the Colo and Macdonald, for example—have preserved fine meanders, and it does not seem reasonable to suppose that such a straight stream as the Warragamba, flowing under exactly similar conditions to the Colo and Macdonald, could have divested itself of all traces of antiquity since uplift. It will be seen that these newer streams are confined to deep valleys and gorges on the eastern side of the Cox Basin.

The great valleys of the Kowmung and Cox, from eight to fifteen miles wide, are occupied by ancient streams. The meanders and horseshoe bends of these streams are not local features, but are found in all varieties of rock types, including horizontal and tilted shale and sandstone, highly-inclined slate and quartzite, and porphyry and granite. The amplitude of the bends varies inversely as the hardness of the rocks in which they occur, but the actual type and character do not change.

The actual form of the valleys of such streams as the Lower Wollondilly and Green Wattle Creek suggests that they are of recent formation. For mile after mile the sandstone cliffs flanking the eastern sides of parts of these valleys are absolutely straight, and are known as Burragorang and Green Wattle "Walls" respectively. They are hardly notched at the top and show no embayments. No tributary streams come over these cliffs to the main streams below. The cliffs of Jamieson's and Grose Valleys are deeply embayed on all sides, and deeply notched at close intervals, even where mere wet-weather streams cross them. These walls are, generally, less than a mile from the river, as close as are the cliffs of the Grose to their river. This would seem to indicate that these walls and the valleys which they flank are of very recent development. For a few miles on the western side of the Wollondilly around Byrne's Creek and Tonalli River much more erosion has been accomplished, but this may have been initiated by streams

flowing westward through the present air gaps near Yerranderie to the Kowmung. The levels of the passes seem to indicate this.

In the case of the Lower Cox Valley, the river above King's Tableland shows characteristic meanders, but downstream these do not appear. Just where the river crosses the King's Tableland-Tonalli scarp a great double "S" bend has been developed on a small unwarped plain just above the scarp. This feature is of recent origin, and is quite different from other Cox meanders, not being fully developed.

The Kowmung-Jamieson's Valley stretches from Wentworth Falls to Bindook, and from King's Tableland to Gangerang Range, having a north-south length of 30 miles and an east-west width of eight miles. The eastern outlet is a gap in the rocky walls less than a mile and a half wide. As the Kowmung Valley has been cut in a series of rocks similar to, although somewhat harder than, those of the Lower Cox Valley, an explanation by differential erosion, particularly in the light of the warping indicated, is out of the question. Also the Cox Valley below this point is quite juvenile. Even the overlapping spurs are preserved. The Lower Wollondilly has every appearance of having developed along a fracture or fault of a linear character. This is not the case with the Nattai, which has a rather tremulous appearance, and is probably an old stream preserving part of its original course, although part has been wiped out by newer streams. Werriberri (Monkey) Creek, which is not much entrenched on the average, and has remarkably few tributaries, also appears to be a relic of an old meridional stream which has been deprived of most of its water by newly-formed streams. Thus the Upper Wollondilly-Kowmung-Upper Cox form an old stream line, whilst the Lower Cox-Wollondilly is of much more recent formation.

Anomalies of Direction.—A survey of the Cox basin shows many anomalies in the direction of stream flow. The normally-branching type of stream is almost absent, and the whole pattern is curiously twisted. Many of the streams are subsequent, being largely determined by rock strike. Hollander's and parts of the Tuglow Rivers, Mumbedah Creek, Breakfast Creek, Marangaroo Creek and many smaller streams come under this heading. The Kowmung runs partly along the strike of the Devonian beds, and also probably follows an ancient fault. A number of the tributary streams join the Cox in an upstream direction. Lowther, Farmer's, Lett, Mumbedah, Kanangra Creeks, the Kowmung and Little Rivers are good examples. These, especially the first-named, which flows in granite, may be due to a former westward drainage. The great arc of the Hollander-Tuglow is parallel to lines of basalt residuals strung along the Kowmung-Wollondilly and Main Divides between Shooter's Hill, Oberon and Yerranderie. Residual streams flowing just along these divides are also parallel to the main arc. The basalt flows, now almost obliterated, appear to have influenced these streams, which are also parallel to the general rock strike.

The Kowmung Basin in particular is asymmetric. It receives no tributaries of note from the east, owing to the proximity of the Black Hollow Creek divide in the main upper valley. Air gaps in the Tonalli Range to the east, however, may indicate the former flow of westward streams into the Kowmung, which might also have received streams from the present area occupied by Black Hollow Creek before the last phases of uplift caused a longitudinal channel to form along the warp in the eastern part of the valley. Mature relics of valleys on the Kowmung-Black Hollow divide indicate such a possibility. The Warragamba is

also asymmetric, as its northern divide is less than four miles from the river. Parts of the Lower Wollondilly are also similar in this respect.

As the streams flow at present, boathook bends, especially that of the Tuglow-Kowmung line, are not at all rare. It is quite impossible to suggest a scheme of stream flow in the past, and post-basaltic, which would be theoretically normal and fit in with observed physiographic facts. It is considered, therefore, that this stream system has been abnormal over a considerable period of time, and its evolution has been determined by very many factors—normal erosion, geological structure, vulcanism and tectonics all having been prominent.

Relationship between the Kowmung and Wollondilly.—The remarkable breach in the divide between these two streams at Bindook Swamp has already been discussed. The asymmetry of the divide is notable, as it is nine miles from the Wollondilly and three miles only from the Kowmung. A large area of the Bindook Swamps and level valleys of the former system, extending three miles south of the divide, is in danger of imminent capture by the Kowmung.

This is the only notable gap in the divide between Mts. Colong and Werong, although numerous narrow gaps occur in the soft Silurian rocks along the divide. The gap becomes even more significant when the course of the Wollondilly is studied. At the junction of Murruin Creek—into which Bindook Creek empties itself—with the Wollondilly, the river turns through 120 degrees, forming the "Murruin Elbow," flowing eight miles in an easterly direction before resuming a northward course. The character of the river also changes at this bend. Above here it swings backwards and forwards in great meanders, which are cut in a canyon 2,000 feet deep. Below the elbow the river has few bends, these few certainly not being meanders. As in the case of the Cox, this indicates different ages for two sections of the stream. The case of the Wollondilly is the more impressive, however, because the character of the gorge does not change here, the deep, broad canyon persisting far upstream.

To the north of the divide at Bindook the ancient Kowmung flows, also sweeping past this point in a great turn. Unlike the Wollondilly it shows meanders both above and below the bend.

The conclusion is, that before the uplift of the Blue Mt. Anticline (here 400 to 600 feet), the Upper Wollondilly and the Kowmung formed a continuous stream, which was broken up by capture, giving the present arrangement. This stream line is post-basaltic in age, as it cuts across the line of old basalt residuals. Apparently at one time the basalt extended continuously along this divide. If that is so, the Upper Wollondilly, Kowmung and Cox originated in Late Tertiary times, and developed their meandering structure after the basalt flows, and before the first uplift of the old anticline.

History of the Stream System.—The conclusion has already been reached that the Kowmung, Jamieson's, Kanimbla and Wallerawang Valleys were once coextensive near base level. The conclusion that the original uplift was here of anticlinal form with the crest near the King's Tableland-Lower Wollondilly line leads one to the corollary that this great valley was cut in the western flank of the fold. The depth varies from 400 feet at Bindook Swamp to 1,500 feet near King's Tableland, gradually shallowing to 1,200 feet in Kanimbla and 500 feet near Wallerawang. The continuous valley opening out from Piper's Flat into the Turon Basin could not have been entirely eroded by the streams now occupying it (cf. Cox's Creek Valley). The line of gravels also points to the presence of a large stream, which once flowed over the present Main Divide. The evidence of

relative age of the various streams proves that the stream system had no outlet to the east. In view of all these facts, then, it appears that the Upper Wollondilly-Kowmung-Cox flowed to the north-west into the Turon before the initiation of the post-basaltic uplifts.

After the uplift of the anticline numerous consequent streams, such as Erskine Creek, Grose River and the Warragamba, were formed on its steep eastern face. These obliterated the old (feeble) drainage, leaving only a few relic streams, such as Werriberri (Monkey) Creek and the Nattai. Pushing back along joint planes, and possibly along fracture lines, these streams cut through the hard plateau sandstones and found the soft Coal Measure shales beneath, rapidly enlarging their valleys. In this way the valleys of the Lower Cox and Wollondilly, Lacy's and Green Wattle Creeks and the Nattai were formed. The valleys of the smaller streams are surprisingly large and well graded, and do not compare unfavourably as regards size with the Wollondilly Valley (Burragorang) itself. This is further evidence that the latter was not always occupied by a large stream. Thus before the initiation of the main Kowmung Warp these streams were attacking the divides of the old Kowmung line to the west.

When the Kowmung Warp commenced, the flow of the Cox was considerably retarded, as the river was pushing against the uplift. The Kowmung and Upper Wollondilly were thrust up, but were not able to cut down very much, on account of the hanging up of the Cox. Thus the low-lying Lower Wollondilly, cutting along lines of weakness, was enabled to capture the high-level, sluggish Upper Wollondilly, and to push back the new divide at the expense of the Kowmung. The Lower Cox River, which had previously almost obliterated the divide between it and Jamieson's Valley, continued this erosive work, and the middle Cox and Kowmung being quite unable to hold to a northward flow against the rapidly rising warp, were, in course of time, captured and reversed. That the Kowmung was able to keep to its original course is shown by its antecedent nature before its junction with the Cox.

During this time the flexure at Hartley had been developing, cutting the Upper Cox off from the Kanimbla streams. The Upper Cox, flowing over Piper's Flat, deposited the older gravels. Using Kanimbla Valley as a base-level of erosion, the Cox above Hartley began to trench its upper course and gradually the whole of the river was reversed. Before this took place, Upper Solitary Creek had been captured and reversed by a tributary of Fish River. The stream flowing along Piper's Flat being reversed, it began to cut into the older valley a little, forming the modern "Piper's Flat", extending from Wallerawang to the present Main Divide. A slight sagging of the crust around Wallerawang, together with some tilting towards Mt. Lambie, caused this flat to dip east, and revived the streams flowing along it, causing erosion of the flat, which is now proceeding, and allowing small tributaries to attack the valley divide of Solitary Creek.

At the head of Cox's Creek, Wolgan River, which had been considerably affected by the old anticline, had cut through the Hawkesbury Sandstone—here fairly thin—and had cut a great gorge in soft underlying Coal Measure strata. At the present time Cox's Creek is being gradually captured.

Since these various stream changes have taken place, the Upper Wollondilly has been able to cut back, and is now entrenched as far upstream as Paddy's River. Kowmung River has cut a profound canyon up to 2,000 feet deep almost to its head, and small tributaries are capturing Bindook Creek, tending to make the

divide here more symmetrical. Marked asymmetry of this divide was caused, in the first place, by the captured Upper Wollondilly being able to cut back in the old high-level valley before the Kowmung was rejuvenated to the great bend. Cox River has cut two series of great canyons, between Wallerawang and Hartley, and between Megalong and Jamieson's Creek. At the present time the stream system is in a state of neutral equilibrium, and only comparatively small captures are pending.

These conclusions have been previously arrived at, in part, by Taylor, who postulated a westward flow for the Cox-Wollondilly. This paper varies his conclusion by suggesting the Upper Wollondilly-Kowmung-Cox as the old stream line.

With regard to the streams of the Nepean system, there is no evidence that they have drained into the western rivers since the commencement of the folding which caused the Blue Mountain anticline. Such a direction of flow, as Taylor has suggested in his papers, was possible before the commencement of this series of uplifts, although I rather incline to the opinion that the Nepean, Cordeaux, Cataract and Avon are comparatively recently-formed streams of consequent type. Taylor's theory of the formation of Kanimbla Valley in the western side of the first fold is definitely established.

Past History of the Area.

a. Earth Movements.

Silurian.—Subsidence. Deposition of sedimentary rocks, since metamorphosed. Now found in western part of area as slates, claystones, limestones, etc.

Unconformity.

Devonian (Lower?).—Further subsidence. Deposition of shales, sandstones, conglomerates, etc., since largely metamorphosed to quartzites, slates, etc.

Devonian? or Carboniferous.—"Kanimbla Epoch". Great folding and mountain building movements. Intrusion of batholith of granite, with sills and dykes of quartz-porphyry. Regional metamorphism. Erosion.

Carboniferous.—Great cycle of erosion. Granite exposed and a peneplain formed.

Great Unconformity.

Permian.—Subsidence and deposition of Upper Marine Series. Present Jenolan Plateau just below sea. Formation of Coal Measure swamps. Deposition of Upper Coal Measures. Continued subsidence.

Triassic.—Deposition of Narrabeen and Hawkesbury beds conformable with Permian. Deposition of Wianamatta Shale to east. Since the close of Triassic, dominant movement here is of uplift.

Cretaceous.—*Uplift and Peneplanation (?). (Sussmilch).

Tertiary (Lower and Middle).—Formation of peneplain. Old rivers, since obliterated by basalts, formed.

*Slight subsidence and deposition of river leads.

Slight uplift and basalt flows (Older Basalt).

Tertiary (Upper) (Physiographic Record).—Erosion. Outpouring of the Newer Basalts (e.g. Robertson).

Formation of great peneplain. Present plateau surface.

Cox-Wollondilly systems take form.

Slight uplift. Valleys of Wentworth Falls type.

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* Signifies no reliable evidence in this area.

Post-Tertiary?—Uplift to the north. Formation of old Blue Mountain Anticline.

Post-Tertiary.—General uplift to south and west. Kowmung Warp and Jenolan Dome.

Hartley fault and Mulgoa-Kurrajong "Step".

Recent.—Canyon Cycle. Erosion of great canyons still proceeding.

b. Stream History.

Upper Tertiary.—Upper Wollondilly-Kowmung-Cox formed. Late mature valleys gave meandering courses.

Eastern streams (Nattai, etc.) flow northwards.

Blue Mt. Anticline.—Kowmung-Kanimbla-Wallerawang Valley cut in fold.

Formation of consequent streams—Lower Cox-Wollondilly, Warragamba and Grose. These eroded deep gorges.

Older gravels, Piper's Flat (?).

Kowmung Warp.—Capture of Upper Wollondilly by present Lower Wollondilly.

Capture of Middle Cox and Kowmung by present Lower Cox.

Reversal of Cox in Kanimbla Valley.

Capture of Upper Solitary Creek by Fish River.

Hartley Fault.—Cox forms canyons above Hartley.

Modern Piper's Flat formed.

Slight depression near Wallerawang. Upward movement towards Mt. Lambie.

Solitary Creek threatened with capture.

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EXPLANATION OF PLATES XIX-XX.

Plate xix.

1. Piper's Flat. View from the Main Divide showing the asymmetric valley; the modern silt flats; and the site of older gravels in middle distance.
2. Silt Flats, Blackheath Glen, Megalong Valley. Note the sharp rise of the talus slopes from the level plain.

Plate xx.

1. Walls of Green Wattle Creek. The flat in the foreground at 400 feet contains rounded pebbles. The straight walls are unbroken for some miles.
2. View up Burragorang Valley. Wollondilly on right and Nattai on left. The valley is approaching maturity. Note the peak residuals on the edge of the cliffs. These are arranged along north-south lines.

FOSSIL PLANTS FROM THE UPPER PALAEOZOIC ROCKS OF NEW SOUTH WALES.

By A. B. Walkom, D.Sc.

(Plates xxi-xxiii; one Text-figure.)

[Read 27th June, 1928.]

This paper contains descriptions of a number of fossils which had been submitted to Professor A. C. Seward at Cambridge by Professor Sir T. W. Edgeworth David. During 1927, while holding an International Education Board Fellowship in Science I spent about nine months working at Cambridge under Professor Seward, and he suggested the examination and description of these specimens as part of my work. During the progress of the work he maintained a close interest in it and helped very materially by suggestions and notes on many points that arose. I desire to acknowledge freely my indebtedness to Professor Seward, not only for his assistance in this particular piece of work, but also for his kindly interest in all that I was able to do whilst working with him and for the inspiration afforded by the privilege of close association with him and his work. To the International Education Board of New York and the Council of the Linnean Society of New South Wales I am deeply indebted for the opportunity to work at Cambridge and other places abroad.

The species described are *Lepidodendron Osbornei*, n. sp., *Ulodendron minus* L. and H., and *Pitys* (?) *Sussmilchi*, n. sp., from the Volcanic Stage of the Kuttung Series; *Stigmaria ficoides* Brongn., from both Volcanic and Basal Stages of the Kuttung Series; *Dadoxylon farleyense*, n. sp., from the Ravensfield Sandstone at the base of the Farley Stage of the Lower Marine Series; and *Dadoxylon Arberi* Seward from the Newcastle Coal Measures at Lake Macquarie.

The relative positions of the horizons from which the fossils were obtained are shown on the following vertical sections of the Carboniferous and Permo-Carboniferous succession in New South Wales, compiled from information kindly supplied by Professor Sir Edgeworth David, and Mr. G. D. Osborne, B.Sc., of the Geology Department of the University of Sydney, who has done much detailed field work on the Carboniferous rocks of the district.

		Feet.
Newcastle Series	Upper Stage	600
	Lower Stage	800 - 1,000
Tomago Series		500 - 1,800
Upper Marine Series	Chaenomya Beds	100 - 150
	Crinoidal Shales	1,500 - 3,000
	Muree Beds	400
	Branxton Beds	2,000 - 3,000
Greta Series		300
Lower Marine Series	Farley Stage	1,000
	Rutherford Shales	1,070
	Lochinvar Stage	2,635

		Feet.
Kuttung Series	Glacial Stage	4,200
	Volcanic Stage	3,000
	Basal Stage	2,300

Burindi Series.

The above section shows the complete succession from the base of the Carboniferous to the top of the Permian. Where to place the junction between the two systems is a much-debated question amongst Australian geologists. Formerly the dividing line was placed between the Kuttung Series and the Lower Marine Series, but in view of the fact that the flora of the Kuttung Series is typically Lower Carboniferous, as judged by the standard of European fossil floras, it is possible that the Lower Marine Series represents the Upper Carboniferous in Australia.

Further detail of the succession in the Kuttung Series (kindly supplied by Mr. Osborne) is as follows:

Glacial Stage, 4,200 feet ..	Upper part: main glacial beds, 1,900 feet. Paterson toscanite, 300 feet. Lower part: sandstone, tuffs, etc., about 2,000 feet.
Volcanic Stage, 3,000 feet ..	Chiefly lavas, tuffs and conglomerates. Martin's Creek hornblende-andesite at base.
Basal Stage, 2,300 feet ..	Upper part: tuffs and sandstones. Lower part: essentially conglomerates.

The horizons in the Kuttung Series from which fossil plants have been obtained are:

(1) About 50 feet below the top of the Basal Stage, where *Lepidodendron* and *Stigmaria* occur.

(2) At the top of the Basal Stage, just underlying the Martin's Creek andesite, where silicified specimens, probably of (?) *Pitys*, have been obtained.

(3) In the Volcanic Stage about 800 feet above the Martin's Creek andesite is the Welshman's Creek Horizon from which abundant plant fossils have been obtained.

(4) *Rhacopteris* occurs on a horizon about 100 feet above the Welshman's Creek horizon.

(5) In the Glacial Stage, about 1,700 feet above the Volcanic Stage, *Lepidodendron* and *Rhacopteris* have both been recorded.

The Ravensfield Sandstone is a band some 20 to 30 feet thick forming the base of the Farley Stage; the beds at Lake Macquarie from which the specimen of *Dadoxylon Arberi* was obtained are about 140 feet below the top of the Upper Stage of the Newcastle Coal Measures.

Although the number of species described from the Welshman's Creek horizon is small, they indicate without doubt that the age of the beds is Lower Carboniferous. The species from the Ravensfield Sandstone shows close resemblance to species from rocks of "Permo-Carboniferous" age in other parts of the world.

(*a*) *Plants from the Kuttung Series.*

LEPIDODENDRON OSBORNEI, n. sp. Plate xxi, figs. 1, 2.

A specimen from the Volcanic Stage of the Kuttung Series at Welshman's Creek has on one side an example of *Ulodendron* (described below) and on the

other a flat impression, about 15 cm. × 3·5 cm., of a Lepidodendroid stem. The general surface of this Lepidodendroid impression is marked by numerous more or less parallel vertical wrinklings, and the most striking feature is the presence of very elongated spirally-disposed, kite-shaped leaf cushions (Pl. xxi, fig. 2). Both above and below, the elongate leaf cushions are continued in the form of a narrow groove; they are 3·5-4 cm. long, and only 4 mm. wide at the widest part, which is somewhat above the middle, 1·2-1·5 cm. from the apex. Situated just above the widest part is a rather small, rounded leaf scar which does not occupy the whole width of the cushion; the leaf scar is about 2 mm. in diameter and in some cases there is a suggestion of a small central scar, and also perhaps of a ligular scar just above the leaf scar.

The leaf cushions are well separated from one another and the general appearance of the impression is very characteristic. It is quite unlike any species previously recorded from Australia, but bears a more or less striking resemblance to species which have been figured from Carboniferous rocks in the Northern Hemisphere. The resemblance is very close indeed to *Lepidodendron spetsbergense* Nathorst from the Lower Carboniferous rocks of Spitzbergen (Nathorst, 1894, p. 37, Pl. 7; 1914, p. 37, Pl. 2, 3, 4, 13, 14). *L. spetsbergense* has similar elongated, kite-shaped leaf cushions which, however, are wider in comparison with their length than in *L. Osbornei*; the leaf scar of *L. spetsbergense*, as in *L. Osbornei*, does not occupy the whole width of the cushion, but in the latter it appears to be situated higher up than in the former. Other species showing considerable degree of resemblance are *L. rimosum* and *L. Glincanum*.

The decorticated stem of *L. rimosum* Sternberg, figured by Zeiller (1886, Pl. lxvii, fig. 4) from the coal basin of Valenciennes, has elongate cushions which resemble those of *L. Osbornei*, but are wider in comparison with their length, and are also much closer together. Zeiller's fig. 5, however, which he also calls *L. rimosum*, shows little resemblance to our specimen and indeed does not appear to be referable to the same species as his fig. 4. White (1899, p. 196) described specimens as *L. rimosum* var. *reticostatum*, one of which (Pl. liv, fig. 3) he described as representing "the impression of the cortex of a stem that seems to be in a Ulodendroid condition". I can see no evidence of this in his figure. The cushions in White's figures 3 and 4 are similar to those of my specimen, and in fig. 4 the vertical wrinkling of the surface between the cushions heightens the resemblance. The leaf scar as seen in the figures of var. *reticostatum* varies in position in that variety, being sometimes at the point where the cushion is widest and sometimes well above this; it does not occupy the whole width of the cushion, a feature in which it also agrees with my specimen. The specimens described by White were obtained from the Lower Coal Measures of Missouri.

Zalessky (1904, p. 88, Pl. 2 and 3) figures several specimens of *L. rimosum* from the Carboniferous basin of Donetz which are undoubtedly of the same general type as *L. Osbornei*. He discusses the differences in the diagnosis of the species by different authors and figures the species under four varietal names; of his examples, those figured as var. *a* and var. *alternans* (Pl. 2, figs. 7 and 8) are similar to *L. Osbornei*, except that, as in other examples of *L. rimosum*, the cushions are comparatively broader and are closer together. The examples of *L. rimosum* figured by Rydzewski from the Polish coal basin are similar to those figured by Zalessky from Donetz, and Rydzewski considers the varieties as representing different states of preservation. In general, his figures do not show

cushions so elongated in their lower half as those of *L. Osbornei*; the scar in the Polish examples is above the widest part of the cushion as in our specimen.

Of the variety of specimens figured by Kidston (1903, Pl. 2-5) from Canonbie as *L. Glincanum* only one (Pl. 5, fig. 41) resembles *L. Osbornei* in the leaf cushions, which are fusiform with long slightly bent extremities and separated by irregularly longitudinally striated cortex. Another species from the Kulm flora of Spitzbergen described by Nathorst as *L. Kidstonii* (1920, Pl. 3, figs. 1-7) shows a close resemblance to our specimen in the narrow fusiform leaf cushions with the scar above the widest part.

It is clear that this specimen from New South Wales is very closely allied to species widely distributed in the Northern Hemisphere in rocks of Carboniferous age, e.g., *L. spetsbergense*, which occurs in Lower Carboniferous rocks in Spitzbergen, *L. rimosum* from Carboniferous rocks in Poland, the Donetz basin, Valenciennes and in the Missouri Coal Measures, and *L. Glincanum* from the Lower Coal Measures of Canonbie. Of these species the resemblance is closest to *L. spetsbergense*—a Lower Carboniferous species.

ULODENDRON MINUS Lindley and Hutton. Plate xxi, fig. 3.

On one surface of an irregularly oblong specimen, about 22 cm. × 7 cm. × 4 cm. thick, there are two circular areas about 4 cm. in diameter and separated from one another by 2-3 mm. The circular areas have a narrow, flat or slightly concave border, about 4 mm. wide, and in the centre an approximately circular depression about 1 cm. in diameter. Between this central depression and the narrow border the surface is slightly convex, and is smooth in the upper half and covered with rows of small projecting knobs in the lower half.

The specimen is very similar to that of a Ulodendroid scar of *Lepidodendron Veltheimianum* figured by Kidston (1885, Pl. 3), though not so large. In Kidston's figure the scar is more elongate (4½ inches by 2½ inches), while in our specimen it is circular (4 cm. diam.), but the two agree in having the smooth narrow border, a central depression, and the intermediate area smooth in one half and tuberculate in the other half. The specimen figured by Kidston came from the Carboniferous Limestone Series of Midlothian. It is also very similar to the specimen figured by Zeiller (1886, Pl. lxxiii, fig. 2) as *Ulodendron minus* from the Eschweiler Mines, in its general appearance as well as in the size and the close proximity of the two scars to one another. Zeiller's figure shows again the smooth narrow border, central depression, and intermediate raised area, tuberculate in one half and smooth in the other. Similar Ulodendron stems are figured from the Culm supérieur of France by E. Bureau (1913) as *U. majus* (Plates xlvi-xlvii) and *U. minus* (Pl. xlviii).

Another somewhat similar example, to which our specimen does not show so close a resemblance, is that figured by Nathorst from the Culm flora of Spitzbergen (1920, Pl. 4, figs. 1, 2) as *Lepidodendron mirabile*. In this the scars are more elongate, about 3·5 by 2·5 cm.; the nature of the markings on the surface is not quite clear, but appears to be similar to that in our specimen.

The specimen so resembles described examples of *Ulodendron minus* from other parts of the World that it seems justifiable to refer it to that species. In comparing impressions such as these it must be remembered that the characters available are perhaps insufficient for accurate specific determination.

The specimen was obtained from the Volcanic Stage of the Kuttung Series at Welshman's Creek.

STIGMARIA FICOIDES Brongniart. Plate xxi, fig. 4; xxiii, fig. 4.

The specimens from three localities in New South Wales may be referred to this "species" which represents in general the underground rhizome of such plants as *Lepidodendron* and *Sigillaria*. At all three localities the rocks are part of the Carboniferous system of New South Wales, and from two (? three), remains of *Lepidodendron* have been recorded.

(*a*) *Stigmaria* from the Basal Stage of the Kuttung Series at Clarencetown, N.S.W. (Pl. xxi, fig. 4).

A large specimen, one surface of which is an almost flat impression of the surface of a Stigmarian axis preserved in a rather coarse sandstone. The impression is about 22·5 cm. long and has a maximum width of about 8 cm., but is bounded on all sides by broken or incomplete margins. The surface is marked by numerous regularly arranged circular scars in some of which there is a small central umbilicus; the scars are arranged in regular spirals and are as much as 9 mm. in diameter.

Parallel to the length of the impression and a little to one side of the middle there is a shallow groove about 6 mm. wide which extends the whole length of the specimen. This groove is superimposed on the impression of the surface of the rhizome and does not interrupt the regularity of the circular scars, some of which it covers but does not hide from view. It represents the remains of the pith and is marked by a number of parallel, longitudinal, discontinuous wrinkles which may be compared with those shown in a specimen figured by Williamson (1887, Pl. xiv, fig. 68, a).

On one side of the specimen, on a surface perpendicular to the impression just described, there are numerous long narrow flattened impressions of rootlets, in some cases obviously connected to the circular scars on the surface of the rhizome. They are at least 8 cm. long; the flattened impression is as much as 1 cm. wide close to the stem, and tapers gradually, being only 4 or 5 mm. wide at the limit of the specimen, some 8 cm. from the scar.

The form of this specimen closely resembles some previously figured examples of *Stigmaria* with rootlets, among which may be mentioned those figured as *Stigmaria ficoides* by Williamson (1887, Pl. xii, figs. 40, 74), Zeiller (1886, Pl. xci) and Seward (1910, fig. 205). Our specimen is the first example with rootlets attached to be described from Australia. *Stigmaria* does not appear to have been noted in descriptions of the Australian Carboniferous flora, but it is possible that some, at least, of the specimens which have been recorded as *Cyclostigma* may be more correctly referred to *Stigmaria*.

(*b*) *Stigmaria ficoides* from the Volcanic Stage of the Kuttung Series at Welshman's Creek, Wallarobba.

A large specimen consisting of portion of a thick, gradually tapering axis. The specimen is somewhat flattened, being elliptical in cross section; it is 21 cm. long, the maximum and minimum dimensions at one end being 16 cm. and 9 cm., and at the other end the corresponding measurements are 13 cm. and 6 cm. The surface is marked by numerous, spirally-arranged circular scars, each with a raised central portion at the apex of which there is a small central depression. The surface is irregularly wrinkled parallel to its length and in addition to the wrinkles there are a number of narrow elongate ribbon-like depressions on the surface; these represent the impressions of rootlets which have not been detached but which have been pressed flat against the surface of the rhizome.

Embedded in the matrix filling the rhizome there is, at the broader end of the specimen, part of the cast of the medullary cavity, with spirally-arranged elongated superficial ridges which, as figured by Williamson (1887, Pl. xiii, fig. 64) represent "prolongations of the medulla into the inner extremities of the primary medullary rays" of the vascular cylinder. Judging from the size and curvature of the portion of this medulla cast preserved, the pith was nearly 1 cm. in diameter, thus corresponding closely in size with that of the specimen described above from Welshman's Creek.

(*c*) *Stigmaria ficoides* from Rouchel (Plate xxiii, fig. 4; Specimen F1403, Geological Survey of N.S.W.).

Two specimens from this locality are casts of portion of the external surface of Stigmarian axes. They show the spirally-arranged circular scars, each about 7 mm. in diameter, with a raised central ring, the centre of which is occupied by a small depression. The surface between the scars is finely wrinkled and the specimens are indistinguishable from those figured by Williamson (1887, Plate xiv, fig. 75) who also explains their structure by his diagram (Pl. xii, fig. 76). A similar specimen is also figured by Nathorst (1914, Pl. 7, fig. 5) from the Culm flora of the sandstones of the Pyramidenberg and other places in Spitzbergen.

Examples of *Stigmaria ficoides* similar to all three types above described are figured by E. Bureau (1913) from the Upper Culm of the basin of the Loire in France.

PITYS (?) SUSSMILCHI, n. sp. Plate xxii, figs. 1-3.

A petrified specimen from Welshman's Creek, Wallarobba, N.S.W., on a horizon near the base of the Kuttung Series, has only portion of the secondary wood preserved, without any of the pith or primary wood, or of the cortex.

Transverse section (Pl. xxii, fig. 1) shows the secondary xylem to be made up of regular radial series of four or five sided tracheids, of rather uniform size. The cells are small, the sides being approximately equal and about 0·05 mm. long. The primordial wall is quite distinct and thin; it has been considerably thickened. The pitting of the radial walls rarely shows in transverse section. The medullary rays are numerous, 1- to 4-seriate.

In radial section (fig. 2) the walls of the tracheids are frequently completely occupied by bordered pits; these pits are usually in three vertical rows, alternate, closely crowded and hexagonal in outline, and have an elongate-oval pore. Sometimes there are less than three vertical rows of pits, and when there is a single row the pits are often in contact and slightly flattened above and below; the single row of pits does not cover the whole wall of the tracheid. The medullary rays consist of radially elongated parenchymatous cells whose radial walls are pitted, the number of pits in the field varying from a single large irregularly oval pit to 6 or 7 small circular bordered pits.

The most characteristic appearance of the wood is that in tangential section (fig. 3), where the medullary rays are very characteristic. They are from one to four cells wide and from one to twenty-four cells high and are very abundant. Occasionally the tangential walls of the tracheids are pitted in the same manner as the radial walls.

The characters of the secondary wood of our specimen allow a reference with little hesitation to the Pityeae and probably to the genus *Pitys*.

Of the species already included in *Pitys* three, *P. Withami* (L. & H.), *P. antiqua* Witham and *P. primaeva* Witham (see Scott, 1902) are characterized

by having primary xylem strands confined to the peripheral region of the pith; a fourth species, *P. Dayi* Gordon, of which an abbreviated account only has been published (in Scott, 1923, 256-260), is distinct from the three above-mentioned species in having primary xylem strands scattered through the whole of the pith region; in this character it shows close relation to the genus *Archaeopitys*, described from the Waverley shale (Lower Carboniferous) of Kentucky by Scott and Jeffrey (1914, 345), which may ultimately have to be included in *Pitys*.

The three species of *Pitys*, viz.: *Withami*, *antiqua* and *primaeva* may be distinguished from one another by the characters of their secondary wood, particularly by the medullary rays; our specimen shows closest resemblance to *P. Withami* L. & H. In the absence of any knowledge at all of the structure of the pith and primary wood in the New South Wales specimen it would be unsafe to refer it definitely to one of the species already described, more especially since the stratigraphical evidence available indicates that our specimen comes from a higher horizon than the three European species which all occur in the lower division of the Calciferous Sandstone (Lower Carboniferous).

Attention may be called to the similarity to species of *Pitys* exhibited by the tangential section of *Sigillaria* (?) *muralis* from Brazil figured by David White (1908, Pl. xii, fig. 2). In this figure the medullary rays resemble those of *Pitys* very closely, but the South American species is apparently quite distinct from *Pitys* in the general character of the secondary wood, which is described as "soft and spongy" (White, 1908, 467).

(*b*) *A fossil wood from the Lower Marine Series.*

DADOXYLON FARLEYENSE, n. sp. Plate xxii, figs. 4-9; xxiii, 1-3.

The specimen is part of a stem from the horizon of the Ravensfield Sandstone in the Lower Marine Series, near Farley, N.S.W. The Lower Marine Series is the lowest division of what is usually known as the Permo-Carboniferous System in Australia. In New South Wales the *Glossopteris* flora makes its first appearance with the occurrence of *Gangamopteris* in association with a marine fauna on a horizon about 2,000 feet above the base of the Lower Marine Series. The Ravensfield Sandstone is a belt of solid sandstone containing abundant marine fossils, and occasional pieces of fossil wood; it is at the base of the Farley Stage, and about 3,800 feet above the base of the Lower Marine Series. The specimen described below is well preserved and shows pith, primary xylem and an incomplete portion of the secondary xylem. In section it is roughly oval, about 9 × 7 cm.; it is not, however, preserved symmetrically about the pith which is not in the centre of the specimen, the longest radius of secondary xylem from the pith being nearly 4 cm. The pith is comparatively small, about 7·5 × 4·5 mm. Annual rings are present, but the greater part of the secondary xylem has been fractured; the structure of the wood itself has not been greatly disturbed by this fracturing, which appears to have been due to a crushing force possibly after petrifaction had been completed or nearly so.

The pith.—The pith is small and broadly oval in transverse section, the longest and shortest diameters being 7·5 and 4·5 mm. respectively; the margin of the pith is a series of almost straight lines giving it the outline of an elongated octagon, from some, at least, of the angles of which, leaf-traces appear to depart. The central portion of the pith is not preserved, a piece about 2 mm. diameter being missing, but the outer part is mostly well preserved (Pl. xxii, figs. 4-6). There is a certain amount of differentiation in the cells of the pith. In the

central part the cells are regularly rounded or hexagonal, with rather thick walls, and fairly uniform in size, about 100 μ in diameter. Outside this there is a zone, irregular in width, in which the cells are thin-walled and exhibit great variation in size, from 35 μ to 140 μ in diameter. At the margin of the pith there is perhaps a narrow region, not more than a few cells wide, where the cells are small (30 μ – 35 μ) and not always easy to distinguish from the primary xylem. This region, however, does not form a distinct medullary sheath like that described in such species as *Dadoxylon indicum* Holden (1917), and our specimen may rather be compared with *D. Lafoniense* Halle (1911). In longitudinal section (Pl. xxii, fig. 4) the cells of the pith are short, rectangular, parenchymatous cells, arranged in fairly regular vertical series; the vertical dimension is on the average about the same as the horizontal, varying from about one-half to twice – 70 μ to 100 μ wide, 35 μ to 200 μ high. Occasionally the fusion of two or three cells in a vertical row produces an elongated cell as much as 280 μ high.

Scattered irregularly through the pith are nests of thick-walled cells, filled usually with dark brown contents. In transverse section (Pl. xxii, fig. 4) the cells of these sclerotic nests do not differ in size or shape from the cells of the central zone of the pith, and in longitudinal section (fig. 5) they are observed to form part of the regular vertical series of cells. Generally many of the cells in a single nest are shorter vertically than horizontally, and often the horizontal cell walls are oblique, giving the cells of the nest a pseudo-radial arrangement. Occasionally the vertical row of cells on one or both sides of a nest is made up of shallow cells, perhaps the result of horizontal divisions of pith cells. The walls do not appear to be pitted. These nests are roughly spherical in shape, sometimes ellipsoidal with longest diameter either vertical or horizontal. The number of cells making up a single nest averages about 15 (varying from 6 to 23) as seen in transverse section; in longitudinal section the nests spread over a number of vertical rows of cells, ranging from 2 to 9, averaging about 6, while the average height of a nest is also about 6 cells. Sometimes adjacent nests are continuous, either vertically or horizontally, connection being made by a few thick-walled cells similar to those forming the nest. The number of such nests observed in the portion of the pith preserved in transverse section was about 20, and as about half of the actual pith is preserved the number in a complete transverse section would be about 40.

Sclerenchymatous groups of cells, giving the pith a very characteristic appearance, have been described in a number of genera, including *Calamopitys* (Scott, 1902, 342), *Mesopitys* (see Scott, 1923, 283), *Rhexoxylon* (Walton, 1925, 11) and *Lyginopteris* (Williamson and Scott, 1895, 717; Seward, 1917, 41), and they are probably not of special importance. No lacunae have been observed near the margin of the pith of *D. farleyense* such as those described by Halle (1911) as mucilage canals in *D. Lafoniense* from the Falkland Is., and which also occur in *Poroxylon*.

Scattered irregularly through the pith there are numerous small, oval, brownish-coloured spots (Pl. xxii, fig. 4) usually about 150 μ by 100 μ, but sometimes considerably smaller, 80 μ by 60 μ.

The primary xylem.—The primary xylem forms a zone (Pl. xxii, fig. 6), about 6-8 cells wide, not distinctly marked off from the secondary xylem, nor indeed from the small parenchymatous cells of the outer pith. There are some definite bundles of primary xylem, but they are not distinctly defined as in the genera *Mesoxylon*, *Calamopitys*, *Mesopitys*, etc. On the whole the tracheids of the

primary xylem are roughly hexagonal in section and tend to be somewhat larger (up to 48 μ by 36 μ) than those of the secondary xylem (40 μ by 32 μ or less); they are not regularly arranged in radial rows like those of the secondary xylem, but there is quite a noticeable degree of regularity in the arrangement of many of the tracheids of the primary xylem. Where primary bundles can be recognized, it is chiefly by the fact that the rows at the sides of the bundle converge from the inner boundary of the secondary xylem. In the bundles it is not possible to differentiate any protoxylem elements in transverse section, though this is perhaps possible in longitudinal section by the presence of annular thickening or very extended spirals. It does seem certain that there is no development of centripetal xylem which is an important feature in determining the generic position of the specimen. In some places the primary xylem bundle appears to extend in two narrow strips into the pith region and to enclose one or two fairly large parenchymatous cells, giving somewhat the appearance exhibited in sections figured by Miss Holden in *D. indicum* (Holden, 1917, Pl. xix, figs. 13, 14).

In radial longitudinal section the primary xylem is formed of some six to eight rows, of which the inner one or two may show annular or very extended spiral thickening, three or four rows show close spiral thickening and two or three rows show scalariform and reticulate thickening, these being followed by the reticulately pitted tracheids of the secondary xylem.

The zone of primary wood is not continuous, and in the areas between the indefinite primary bundles the parenchyma of the pith is continuous with the medullary rays.

The secondary xylem (Pl. xxii, figs. 7-9).—The secondary xylem shows the usual regular arrangement in radial rows, of more or less equidimensional rectangular cells with uniseriate or biseriate medullary rays. Annual rings are clearly distinguishable, there being a distinct line of demarcation between the summer wood of one ring and the spring wood of the succeeding ring; on account of the shattering of the stem it is not possible to follow the rings right round the stem, but they can be traced for considerable distances and always end abruptly where the wood has been fractured. In radial section also there is a distinct difference between summer wood and that of the succeeding spring. The rings vary from about 5 to 8 mm. in width.

The radial walls of the tracheids have one or two, occasionally three, vertical rows of large, alternate, circular bordered pits (see fig. 8). When there is only a single row the pits are sometimes in contact and flattened, but at other times they are separate from one another and retain their circular outline. When there is more than a single row the pits are in contact but are not so closely packed as to have the hexagonal outline so common in woods of similar type to our specimen. Occasionally the pits in two vertical rows are opposite instead of alternate. The pore in the bordered pits is small and broadly elliptical in outline, generally elongated transversely.

The medullary ray cells are parenchymatous and generally from three to seven times as long (radially) as high. Their radial walls are pitted with small elliptical bordered pits, the number varying up to about seven in the field.

Tangential sections (fig. 9) show the rays generally to be uniseriate, occasionally biseriate, and varying from 2 or 3 to 21 cells in height. No pitting was observed on the tangential walls of the medullary ray cells but occasionally there appeared to be one or two rows of alternate bordered pits on the tangential walls of tracheids of the secondary xylem.

General Discussion.

Dadoxylon farleyense agrees very closely in many of its characters with *Dadoxylon Lafoniense* described by Halle (1911, 177) from Permo-Carboniferous rocks of the Falkland Is.; the two species resemble one another especially in the absence of marked distinction between primary and secondary xylem and in the absence of centripetal xylem. The presence of annual rings and the pitting of the radial walls of the tracheids add to the resemblance. In the former species the medullary rays are considerably higher than in *D. Lafoniense*, and the presence of an abundance of sclerotic nests in the pith of *D. farleyense* is another point of difference.

The genus *Mesopitys* Zalessky, in which annual rings are well marked, has definite strands of primary xylem described by Zalessky (1911, 28) as being wholly endarch, an observation which has not been entirely borne out by re-examination of his material (see Seward, 1917, 295; Scott, 1923, 283); the leaf-trace is a single strand where it passes through the secondary xylem. Our species differs from *Mesopitys* in having apparently no centripetal xylem and in having only very indefinite primary xylem bundles; it has also much higher medullary rays, but has a similar type of pith with abundant sclerotic nests.

D. farleyense is another addition to the species of *Dadoxylon* with structure of the central region preserved, from the Gondwana flora. Although silicified woods are very common on some horizons in rocks of Permian (Permo-Carboniferous) age from the Gondwana region, in very few cases has the structure of the central region of the stem been sufficiently well preserved for description. The cases in which knowledge of the pith and primary wood is available include *Dadoxylon Pedroi* Zeiller (1895) from Brazil, *D. Lafoniense* Halle (1911) and *D. Bakeri* Seward and Walton (1923) from the Falkland Islands, *D. indicum* Holden (1917) from India, *D. sclerosum* Walton (1925) from South Africa and the stem described as *Araucarioxylon Daintreei* from Queensland (Chapman, 1904, 320). Very little is known of the pith or primary xylem of *D. Arberi* Seward (1919, 255), the characters of the species being those of the secondary xylem; Walton (1925, 2) has described a specimen of *D. Arberi* from South Africa in which some crushed remains of pith and primary wood are preserved. *D. farleyense* differs from *D. Arberi* in having numerous sclerotic nests in the pith, and also in the character of the pitting on the radial walls of the tracheids. *D. farleyense* may be closely related to the stem from the Bowen River Coal Measures in Queensland described by Chapman (1904) as *Araucarioxylon Daintreei* but in the latter the medullary rays appear always to be uniseriate and the bordered pits on the radial walls of the tracheids are often in 4 to 6 vertical rows and have an oblique slit-like pore.

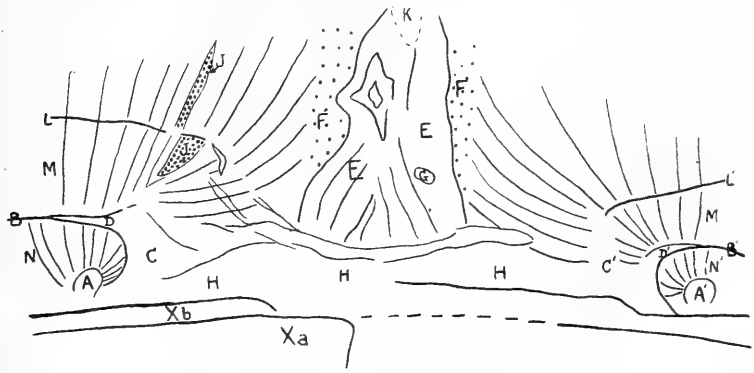
D. Bakeri Seward and Walton (1923, 325) is a similar type of wood occurring in association with *Glossopteris* in the Falkland Is.; it does not possess secretory reservoirs or canals like *D. Lafoniense* Halle, it has a zone of tissue lining the inner side of the primary bundles such as is present in *D. indicum* Holden, and the pits on the radial walls of the tracheids are often in stellate groups recalling the distribution of pits characteristic of the genus *Callixylon* which occurs in the Upper Devonian of Indiana. In all the features just mentioned *D. Bakeri* is to be distinguished from *D. farleyense.*

Recovery from wound and development of callus. Plate xxiii, figs. 1-3; Text-fig. 1.

The sections of this specimen of *D. farleyense* have been cut through portion of the stem where there was a roughly circular projecting scar, about 15 mm. in

diameter, with a fairly well defined outer rim about 1 mm. wide and a depressed central area (Pl. xxiii, fig. 3). From these sections it appears that this scar is the result of a wound, perhaps the breaking of a branch, which has been repaired by the development of callus growth and the gradual lateral extension of wood over the wound area. The figures (Pl. xxiii, figs. 1, 2) show close similarity to examples of callus growths (*cf.* Hartig, 1878, Plates v and vi; Küster, 1925, figs. 51, 53, 78, 82, 102, 105), and the specimen is thus of considerable interest as being one of the very few cases so far recorded amongst fossils. It also shows, as of course is to be expected, that the methods of recovery from wounds were the same in bygone ages as they are to-day; both in outward appearance and in sections the fossil is very similar to recent examples of the same phenomenon. Plate xxiii, fig. 2, shows a section near the central portion of the wound; fig. 1 one near the margin.

The general structure is well shown in transverse section (Text-fig. 1). At Xa in the figure is a normal annual ring of the secondary wood. The next succeeding ring, Xb, is abruptly broken off after the spring wood has been developed to a thickness of about 0·7 mm., whereas the annual ring Xa is about 3·7 mm. thick. On the level at which the slide is cut this break of the secondary wood has a lateral extent of nearly 2 cm. Where the wound has been received, and particularly at the outer margins, groups of rather loose parenchymatous cells



Text-fig. 1.—Recovery from wound in *Dadoxylon farleyense*. Diagram illustrating Plate xxiii, fig. 2. Explanation in text.

have been developed (A, A^1, H). These cells have very much the appearance of cortical tissue and their formation has been accompanied by the secretion of a considerable amount of resin as evidenced by numerous cells in the vicinity filled with darkish-brown contents. Such loose parenchymatous tissue is characteristically developed in the formation of callus wood (see Küster, 1925, fig. 48). At A and A^1 it appears that some of the cells of this tissue must have developed cambial activity for, from the outer margins of the two groups, series of regularly arranged rows of tracheids radiate, and by spreading inwards they commence to repair the damage caused by the wound. At the lines marked B and B^1 there is every appearance of the termination of a season's growth, but this radial discontinuity dies out laterally in a very short distance (3 or 4 mm.) and would perhaps seem to have been due to some check in growth round the wound. Along the surface where this check took place there is a narrow wedge

(D, D^1) of loose cells, resembling cortical tissue, which expands when it reaches the edge of the wound region into an extensive mass of loose cells forming a callus over the broken edge of the wound (C, C^1). In a radial direction this passes gradually into the series of regularly arranged rows of tracheids of the secondary xylem. The narrow wedges (D, D^1) just mentioned are also succeeded radially by regular rows of tracheids and a little further out (at L and L^1) there is the normal well-defined boundary of an annual ring. The ends of this outer part of the annual ring (M, M^1) encroach further on to the wounded region than those of the earlier part (N, N^1).

In the central part of the wound area there are confused masses of cells (E) where, for the most part, the structure is not well preserved and it is possible that some of the groups of cells may have belonged to the basal part of a broken branch. On either side there is a zone of loose irregular thin-walled parenchyma (F) (similar to that at C, C^1) and merging into the secondary xylem which finally completely encloses the wound zone. At K there is a small group of large, rather thick-walled cells very like those forming the pith, and scattered through the whole of the wound region there are numerous small oval brown spots whose presence in the pith has been noted above. In places, particularly in the vicinity of A and A^1 and in the rows of cells radiating therefrom, and also at J, many of the cells are filled with darkish-brown contents, perhaps resinous secretion induced by the wounding.

The small circular mass at G consists of a small central group of rather large thick-walled cells surrounded by a zone of thinner walled cells and then a narrow zone several cells wide in which the cells are arranged in regular radial manner.

Radial sections show very distinctly the sudden change from the secondary xylem to the loose callus tissue, and in the outer portion of this the appearance is very similar to Küster's figure of abnormal fibre formation in response to injury (Küster, 1925, fig. 82, p. 120).

(c) *A fossil wood from the Newcastle Coal Measures.*

Dadoxylon Arberi Seward.

Portion of a petrified stem from Lake Macquarie, on a horizon within the Newcastle Coal Measures, is referred to *Dadoxylon Arberi*.

The specimen consists of portion of the secondary wood from the outer part of the trunk. Distinct annual rings are present and from the curvature of these rings it is obvious that the stem was more than 12 inches in diameter. The rings are fairly regular and are from 3 to 6 mm. in width. The radial rows of tracheids and the medullary rays are considerably distorted and do not follow a straight radial direction.

In transverse section the tracheids of the spring wood are small, approximately square, about ·05 × ·05 mm., and are two or three times the dimension of the summer wood tracheids in a radial direction, the latter being approximately ·05 × ·02-·04 mm. The greater part of the annual ring is made up of the spring wood; there are up to 20 rows of thicker-walled tracheids in the summer wood, occupying less than 1 mm. in width, and the rings vary from 3 to 6 mm. in total width.

The preservation of the pitting of the walls of the tracheids is very imperfect and incomplete. The radial walls have large, approximately circular bordered pits with a wide border and a fairly large transversely oval or circular pore. There may be as many as four vertical rows of pits or only a single row. When

there are four rows they are alternate and so crowded that they are hexagonal in outline and they cover the whole surface of the radial wall. When there are only one or two rows of pits they are not always in close contact and may be circular or slightly flattened top and bottom by contact with adjacent pits, and may be opposite instead of alternate.

The medullary rays are only poorly preserved and no example was observed of pits communicating with the tracheids. In tangential section the rays are very abundant and almost always uniseriate; occasionally one or two cells near the middle of the ray may be divided into two vertically. The height of the ray varies from 2 cells to 30 cells, the majority being between 6 and 15 cells high, and the cells are almost square, with somewhat rounded corners. The number of rays visible in tangential section is about 20 per square millimetre.

It seems more than probable that the specimen belongs to the species originally described by Arber (1905, 191) as *Dadoxylon australe*, now known as *D. Arberi* (Seward, 1919, 255), with which it agrees fairly closely in most of its characters. Arber's specimens were from the Newcastle Series at Newcastle and Lake Macquarie, and our specimen comes from the latter locality. Walton (1925) has recently described *D. Arberi* in greater detail than the original account. In our specimen the diameter of the pits on the radial walls of the tracheids is about ·01 mm., and that of the tracheids themselves about ·05 mm.

It was in this species that Arber (1905) first called attention to the development of well-marked annual rings in fossil woods from Permo-Carboniferous rocks. Several additional species showing this feature have since been described and in most of them the structure of the central portion of the stem is known, but we still know comparatively little of the structure of this region in *D. Arberi*. Two Indian species described by Miss Holden (1917) both differ from *D. Arberi*, *D. indicum* particularly in the pits on the radial walls of the medullary rays and *D. bengalense* in having the rays always uniseriate. Other species of *Dadoxylon* such as *D. Lafoniense* (Halle, 1911) and *D. farleyense* (described above) have secondary wood very similar to that of *D. Arberi*, but the name *D. Arberi* is perhaps best reserved for secondary wood alone, other specific names being used when knowledge of the central region of the stem is sufficient to justify use of a separate name.

Two species from Brazil, *D. nummularium* and *D. meridionale*, described by David White (1908, 579, 583) have secondary wood of much the same general type as *D. Arberi*, but in neither species is there any evidence of the development of annual rings.

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EXPLANATION OF PLATES XXI-XXIII.

Plate xxi.

Figs. 1, 2. *Lepidodendron Osbornei*, n. sp. Welshman's Creek, Wallarobba, N.S.W. 1. Photograph (slightly enlarged) of specimen; 2. Drawing, by Mr. T. A. Brock, of Cambridge, showing the very elongated, kite-shaped leaf cushions (slightly reduced).

Fig. 3. *Ulodendron minus* L. and H. (× ½). Welshman's Creek, Wallarobba, N.S.W.

Fig. 4. *Stigmaria ficoides* Brongniart (× ½). Clarencetown, N.S.W. Showing the remains of the pith and of the numerous flattened rootlets.

Plate xxii.

Figs. 1-3. *Pitys* (?) *Sussmilchi*, n. sp. Welshman's Creek, Wallarobba, N.S.W. (× 25). 1. Transverse section; 2. Radial longitudinal section, showing the alternate, closely-crowded pits; 3. Tangential section showing the characteristic medullary rays.

Figs. 4-9. *Dadoxylon farleyense*, n. sp. Ravensfield Sandstone, near Farley, N.S.W. (× 25, except fig. 8, which is × 60).

4. Transverse section of portion of the pith, showing three of the "sclerotic nests" and, in the top left hand corner, some of the oval brownish-coloured spots which are of frequent occurrence not only in the pith, but in other parts of the wood. 5. Longitudinal section of the pith. 6. Transverse section showing outer portion of the pith, primary xylem and secondary xylem. 7. Transverse section of secondary wood showing junction between two annual rings. 8. Longitudinal section of the secondary wood showing pitting of radial walls. 9. Tangential section of the secondary wood.

Plate xxiii.

Figs. 1-3. *Dadoxylon farleyense*, n. sp.

1. Transverse section (× 4) near margin of wound caused, probably, by breaking off of a branch. The callus tissue repairing the wound shows in this section as an elongate band of cells, similar in appearance to cortical cells, extending for about two-thirds across the middle of the photograph. 2. Transverse section (× 4) nearer the centre of the wound than Fig. 1. The details shown are explained in the text and in Text-fig. 1. 3. Photograph (approx. nat. size) of the specimen after sections had been cut.

Fig. 4. *Stigmaria ficoides* from Rouchel, showing root scars (approx. nat. size).

REVISION OF THE AUSTRALIAN SPECIES OF THE GENERA *CURIS*, *NEOCURIS* AND *TRACHYS*, TOGETHER WITH NOTES AND DESCRIPTIONS OF NEW SPECIES OF OTHER COLEOPTERA.

By H. J. Carter, B.A., F.E.S.

[Read 27th June, 1928.]

Cerambycidae.

Athemistus nodosus, n. sp.

Chocolate brown; tarsi, apex and base of tibiae pale fawn colour; head and raised parts of upper surface with close adpressed downy pubescence; antennae and tarsi more strongly pubescent.

Head with a few punctures on vertex, antennae stout. *Prothorax* convex, sides evenly and very lightly rounded, sides without apparent tubercles, whole surface very uneven and dotted with coarse, subfoveate punctures, disc with five small tubercles, three in a line near middle, two smaller and closer behind these, the five outlining a subplanate area (found in other species). *Scutellum* very small and round. *Elytra* narrowly ovate, apices bluntly, separately rounded; each with three rows of prominently raised, obtuse nodules, the second row containing the larger nodules, at the base forming a crest, giving an irregular outline to base of elytra; two prominent triangular tubercles on apical declivity; on each side of suture and between the pustules are rows of large punctures more conspicuous than in *A. monticola* Blkb. *Dim.*: 7·5 × 3 (—) mm.

Hab.—Victorian Alps (Bogong High Plains, above 5,000 ft. alt., Mr. F. E. Wilson).

Two examples, one certainly ♂, have been sent by their captor for description. The species is readily distinguished from its nearest allies *A. punctipennis* Cart., and *A. tricolor* Cart., by the uneven pronotum, and the large size and small number of the elytral nodules besides the crested humeri.

Holotype in Coll. Wilson.

Buprestidae.

Neobubastes aureocincta Blk. = *Castelnaudia australasiae* Obenb.—In *Sbornik Entomol. Nat. Mus. Praze*, 1923, p. 14, Dr. Obenberger describes a species that is clearly identical with Blackburn's species, while he uses a generic title that was used by Tschitscherine in 1891 for a genus of the Carabidae (since altered to *Castelnaudina*, *Sbornik*, 1924, p. 17).

Buprestina prosternalis Obenb.—In the following page to that which contains the above species occurs a description of a new genus *Buprestina* with its genotype *B. prosternalis* Obenb. This, in many respects, is very near the genus that I (at a later date—July, 1924) described as *Notobubastes*, but certain inconsistencies make this uncertain. Thus in *Buprestina* the elytra have the "apices conjointement subarrondi", while in *Notobubastes* the apices are "tridentate". Yet in a specimen of *N. orientalis* from Wide Bay, Queensland, I find the apices irregular, the left hand apex being subtruncate, the right hand one lightly tridentate. There is also a curious contradiction in Dr. Obenberger's description. Thus in the generic diagnosis the prosternum is said to be "densement ponctué",

while under the species "Prosternum sans ponctuation, lisse" makes determination a little difficult.

Diceropygus maculatus Deyr. = *D. quadritinctus* Obenb.—I have recorded *D. maculatus* Deyr. from Darwin, North Australia (*Trans. Ent. Soc. Lond.*, 1923, p. 103). Obenberger's description evidently shows the same insect.

Briseis conica L. and G. = *B. sagitta* Obenb.—I believe also this synonymy holds good. There is no value in describing species which are so evidently close to well known species without clearly indicating their definite distinction.

Hypocisseis Thoms.—In *Archiv für Naturg.*, 1924, p. 106, Dr. Obenberger disagreed—without giving a reason—with my placing *Cisseoides* Kerr. as a synonym of *Hypocisseis*. However, in *Sbornik Entom. Mus. Praze*, 1924, p. 24, he follows this up by stating the four characters which he considers differentiate *Hypocisseis*. He has hereby strengthened my former considered opinion after a re-examination of material.

For the purpose of replying to my critic I will compare two well known species, *H. latipennis* Macl. = *laticornis* Thoms., the genotype of Thomson, with *H. suturalis* Saund., which Kerremans redescribed (1) as *Cisseoides albopicta* and (2) as *Hypocisseis aeneipes* (afterwards corrected to *Cisseoides aeneipes* in the *Genera Insectorum*) and whose types I examined in 1922.

The four characters stated by Obenberger are:—(1) "la taille beaucoup plus large, robuste et subdéprimée"; (2) "la présence de deux faisceaux de poils élevés sur le front"; (3) "le marge basale du corselet, qui est très largement rébordée"; (4) "la forme de tibias (*sic*) postérieurs, qui sont, au côté externe, légèrement relevés en gouttière (vraisemblement pour y loger les premiers articles de tarse au repos) et dont partie apicale et extérieure est subglabre ou très éparsement unisériatement épineuse, tandisque les épines citées sont chez *Cisseoides* denses et subégales, unisériatement disposées sur toute la longueur de tibie".

With regard to (1), there is no more difference in size and form between the species in my tabulation than in other genera (e.g. *Cisseis*). Thus dimensions of *H. latipennis* are 10-12 × 4½-5 mm., of *H. suturalis* 6½-10 × 3-4 mm. Also mere size has little to do with generic distinction.

(2). The tufts of hair are merely crests to elevations bordering the eyes. All the species in my table have this elevation more or less, without the tufts of hair, as also has *H. brachyformis* Deyr., which Dr. Obenberger admits into *Hypocisseis*.

(3). This seems quite imaginary. I find no mention of it in the original description, nor any sign of distinction between the species in my tabulation.

(4). The hind tibiae of the two species differ, but only to a slight extent. There is little sign of the "gouttière". Both are flattened near apex, this flattened area extending farther in "*latipennis*" than in "*suturalis*", but both have the exterior edge sharp and strongly "unisériatement épineuse".

There is nothing of a generic character that warrants the separation of *Cisseoides* from *Hypocisseis*. Monsieur Théry has already noted his accord with this opinion (*Ann. Soc. Ent. Belg.*, 1927, p. 33).

As with all widely distributed species, *H. suturalis* Saund.—found on *Exocarpus cupressiformis* (the Native Cherry) in New South Wales, probably on allied trees in Western Australia—is very variable in size and pattern, the latter easily abraded. The four species described as *Cisseoides carteri*, *C. maduri*, *C. gebhardti* and *C. nigrosericea* are under suspicion as possible additional synonyms of this already four times described species.

Anthaxoschema Obenb. = *Notographus* Thoms.—There seems little doubt of this synonymy. The characters specially mentioned by Obenberger—the antennary cavities unseen from in front, with "ligne antérieure . . . un peu élevée latéralement en carène", the form of pronotum, and the apical segment of abdomen are all exactly the characters which distinguish *Notographus* from *Anilara*.

Anthaxoschema terraereginae Obenb. must be very close to the species I have hypothetically diagnosed as *Notographus yorkensis* Obenb., but the abbreviated descriptions contained in the tabular form (*Entom. Blätter*, 1922, pp. 72, 73) do not enable me to state this synonymy with certainty. Both descriptions fit large and small examples of a species variable in size and widely distributed in Queensland, a fresh example of the larger fitting *N. yorkensis*, a small, stained or abraded example fitting *N. terraereginae*.

Stigmodera cara Blkb.; *S. placens* Kerr.—This is a well known species in the Stanthorpe district, S. Queensland. The ♀ (not mentioned by either author) has the abdomen concolorous with the rest of the underside—blue or violet—this region being more or less yellow in the ♂—a sexual variation noted in other species (*Trans. Roy. Soc. S. Aust.*, 1916, p. 83).

Diceropygus (*Melobasis*) *suturalis* Macl.—Monsieur Théry has recently indicated, in correspondence with me, that this species is a *Diceropygus*, though described as a *Melobasis*, and so included in my Revision. This author also shows that *Diceropygus* can only be maintained with subgeneric rank.

Synechocera elongata Thoms. = *S.* (*Aphanisticus*) *occidentalis* Macl.—This synonymy is established by the comparison of a paratype of Thomson's species, sent by Mons. Théry, with an example in my collection that is identical with Macleay's type.

Cisseis elliptica Cart. = ? *C. carteri* Obenb.—There is nothing but a slight difference of size in Obenberger's description to distinguish it from *elliptica*.

Meliboëithan Obenb.—I cannot find anything in the description of this genus to distinguish it from *Paracephala*, while the species described under it, *M. fissus* Obenb., might well be *Paracephala intermedia* Kerr.

MELOBASIS PUSILLA, n. sp.

Oblong; metallic green above and below, including appendages.

Head, including eyes, slightly wider than apex of prothorax, front wide, slightly widening in front of eyes, densely and regularly punctate. *Prothorax*: Apex and base lightly bisinuate (especially the former), sides lightly widened in middle, all angles subobtuse, disc closely covered with round punctures, becoming denser and coarser at sides, these punctures superimposed upon a minutely roughened surface, seen more distinctly on oval prescutellary impunctate patch. *Scutellum* transverse, oval. *Elytra* widening behind shoulders, lightly compressed near middle, sides subparallel, apical margins serrulate; disc closely punctate with rather vague indications of a linear arrangement, the punctures very dense (also colour brighter) near base, the humeral callus impunctate.

Underside of head and prosternal episterna coarsely, prosternum densely, metasternum less strongly, punctate; abdomen with elongate "finger-print" impressions, open behind; these very dense towards apex—except on margins; apical segment of ♂ truncate between two short spines; the larger example (? ♀) has lost the abdomen. *Dim.*: 6-7½ × 2-2½ mm.

Hab.—Queensland: Bowen (A. Simson, in Simson Collection, South Australian Museum).

Two examples of this pretty little species sent amongst some *Neocuris* are, I think, correctly placed in *Melobasis*—though at first glance taken for a *Pseudanilara*. The bispinose abdomen and the form of head and pronotum point to this position. The very slightly lineate arrangement of the elytral sculpture is not very far removed from a similar occurrence in *M. uniformis* Cart., and *M. macleayi* Cart., while it is nearer the latter in colour, but of a brighter green. *M. macleayi*, however, has the sides of prothorax quite straight, its surface punctures with a transverse tendency, and the elytral series more clearly traceable.

Holotype and allotype in the South Australian Museum.

ANILARA DODDI, n. sp.

Short and rather convex; nitid blue-black, glabrous.

Head deeply immersed in prothorax, and much narrower than it, front generally convex but clearly channelled in middle, eyes with internal margins parallel, vertex wider than the transverse diameter of an eye. *Prothorax* more convex than usual, apex arcuate, the front angles acute and depressed; base nearly straight, sides well rounded, widest at basal third, thence arcuately narrowed to apex and lightly to the subobtuse posterior angles; whole surface minutely, not densely punctate, with transverse rugae near base; without medial line or foveae. *Scutellum* nearly circular, nitid. *Elytra* slightly wider than prothorax at base, jointly at apex, basal margin raised, having a large subhumeral depression behind it; finely scalose-punctate, the punctures more distant than on pronotum. Underside nitid and almost impunctate. *Dim.*: 3 mm. long.

Hab.—Queensland: Kuranda (F. P. Dodd).

A unique example in the South Australian Museum is another of the well known naturalist's captures in this prolific region. Its abbreviated, rather wide and convex form and depressed, anterior angles suggest generic distinction. The elytra in the holotype are dehiscent and disclose a wide, nitid band at base of pronotum, with a fine, sharply serrulate margin; this band usually covered by elytra.

Holotype in South Australian Museum.

STIGMODERA MACULIFER Kerr.—I have already noted (These PROCEEDINGS, 1924, p. 19) the distinction of this eastern species from the western *S. rubriventris* Blkb. They are so frequently confused that the following comparison may be useful:—

	rubriventris.	*maculifer.*
Form—		
	Narrower, sinuate, attenuate behind, each apex obliquely acuminate.	Wider, oblong oval, rounded behind, each apex lightly bispinose, with small lunation.
Elytral intervals—		
	Clearly punctate.	sub-laevigate.

Both species have the apical margins denticulate, but so faintly in *rubriventris* that its author may be excused for failing to see this; unless with the aid of a binocular microscope.

Other differences, especially of colour, are less constant, but I have lately seen such striking variations in examples from Stanthorpe, Q., that, for the present considered as a variety, may later be deemed of specific value.

S. MACULIFER Kerr. var. AERICOLLIS Cart. Head, pronotum and underside, except abdomen, brilliant golden coppery; elytra chiefly testaceous, fasciae

variable. In one case only the post-medial dark fascia is present with a minute apical patch; in another example even this fascia is reduced to two lateral spots and the apical patch is wanting.

PARACEPHALA BICOSTATA, n. sp.

Short, rather wide; above and below obscurely coppery, thickly clothed with recumbent silvery hair, head, pronotum and underside showing slight metallic gleams, elytra more opaque.

Head suborbicular, with deep longitudinal furrow, situated in a cuneiform excision. *Prothorax* very convex, apex advanced in middle, base strongly bisinuate, sides slightly arcuate in middle, and a little sinuate behind, posterior angles subacute, the anterior quite rounded off; disc without channel, the thick, bristly hairs tending to form an oval around a nude, raised mediobasal area. *Elytra* as wide as prothorax at base, sides subsinuate, slightly widest behind middle, shoulders forming callosities, a sinuate costa extending from each shoulder to apical declivity, parallel to suture on its hinder half; the sculpture hidden by clothing. Underside much more sparsely pilose except at sides; rather strongly punctate. *Dim.*: 4·5 × 2 (+) mm.

Hab.—Queensland (National Museum); Western Australia: Pinjarrah (A. M. Lea); Australia (S. Aust. Museum).

Seven examples examined, two from the National Museum, four in the South Australian Museum and one (No. 7303) in Mr. Lea's Coll. show a species of shorter and proportionally wider form than usual. It is clearly not one of the three species inadequately described by Dr. Obenberger*, while I think I know the other described species. It is the most densely hirsute species known to me, also the only one having a defined elytral costa (*P. intermedia* Kerr., shows a subcostiform impression due to the presence of a subsutural groove), the costa emphasized by the clothing, as with the raised part of pronotum. I cannot distinguish any sexual characters.

Var.—A specimen from Ardrossan, S.A. (G. Tepper), in the Adelaide Museum is I consider conspecific, differing from the typical form in its larger size (6 mm. long) and more metallic but strongly pubescent surface.

Holotype and paratype in National Museum.

SYNECHOCERA LONGIOR, n. sp.

Elongate, parallel, depressed; black, subnitid; everywhere with a short, sparse, inconspicuous pale pubescence.

Head globose, the front with a deep incision, dividing it into two lobes; eyes not prominent, antennae having segments 6-11 dentate, the 5th also a little enlarged at apex. *Prothorax*: Apex lightly, base more strongly sinuate; anterior angles produced but deflexed, posterior obtuse; widest at anterior third, there as wide as elytra at shoulders, thence arcuately narrowed each way; disc with elongate-oval depression at anterior middle, with small, sparse, setose punctures. *Scutellum* rather large, acutely triangular. *Elytra* parallel for the greater part (very slightly obovate), widest at subgibbous shoulders and behind middle, apices very slightly dehiscent and separately rounded, their margins entire; disc covered with lightly impressed punctiform depressions, each bearing a short white hair,

* Archiv fur Naturg. 1924, p. 155. No comparison with existing species is given, nor any note to show the author's knowledge of them. Moreover, there is little in the description of *P. niveiventris* to distinguish it from *P. strandi*, while I think it is certain that *P. impressicollis* Obenb. = *P. transsecta* Cart.

each elytron with a faintly indicated costa throughout its length; underside even more lightly than the elytra but similarly impressed. *Dim.*: 7·5-9 × 2-2·5 mm.

Hab.—Victoria, South Australia and Western Australia.

Five examples are before me, that I had provisionally labelled *elongata* Thoms., but Monsieur Théry has recently sent me a paratype of Thomson's species that is unmistakably identical with *occidentalis* Macl.

S. longior differs from *elongata* in larger size, black colour, much finer sculpture, stronger frontal excision; the pronotum longer and relatively narrower, its front margin less produced in middle; the base of elytra less strongly bent (almost forming two semicircles in *elongata*). Three examples (the type series) were taken by Mr. J. E. Dixon at W. Warburton, Victoria; one is from a series taken at Lucindale, S. Australia and the fifth was taken by myself at Geraldton, W.A. This distribution is very wide, but I cannot separate the individuals specifically. The Geraldton example is a more nitid black with, possibly, finer sculpture and less obvious setae, but it is, at most, only a variety.

S. setosa is smaller and more cylindric, while *S. tasmanica* Thoms., has a subcircular prothorax. Type series in Coll. Carter.

Revision of the Genus Curis *L. and G.*

Though I have only one new species to add there are some corrections to make in the nomenclature, and a tabulation to add that will, I trust, make the study of this beautiful genus clearer.

The Synopsis of Fairmaire, published in 1877 (*Ann. Soc. Ent. France*) was the last general survey of the group, since when six species have been added, one each by C. O. Waterhouse and Blackburn, three by myself and one by Obenberger. Twenty names have been published for species, of which six are, I consider, synonyms, while one, *C. despecta* Fairm., is unknown to me. The remaining thirteen are tabulated below, together with the new species. The genus is specially interesting in that it is, I think, alone of Buprestidae, in having representatives in South America, three species being recorded by Kerremans in 1902 from Chili. I have one of these, *C. bella* Guér., kindly sent by Mons. Théry, that is strikingly close to some of the Australian species.

Fairmaire's synopsis contains so many inconsistencies, while the characters by which he defines his groups are of so doubtful value that I have not made much use of his arrangement. Thus *C. perroni* L. and G. is placed, together with *C. despecta* Fairm., under group A, of which the chief distinction is "caput antice non aut vix impressum", yet in his following description occurs "capite . . . longitudinaliter impresso". A little further on he says "elytris *apice acuminatis*, tenuiter serrulatis, *apice obtuse rotundato*". If one may adopt the second part in each of these cases and eliminate the first, the determination of this name by the late Canon Blackburn for an insect in the South Australian Museum—labelled Australia—is, I think, correct. This interpretation is corroborated, so far as concerns the frontal impression, by the note under *despecta* which states that "tête . . . plus largement et moins profondément excavée" though this leaves the group character of A still more incomprehensible.

Colour.—Bewilderingly varied in some species, so that I have, except where colour characters are more or less constant, taken structure and sculpture as a surer guide.

Structure.—Dr. Obenberger lays much stress on the width and form of the interocular front of head. I find this is partly a matter of sex; as is also the

question of dimensions. Thus in examples of *C. splendens* Macl., taken by Mr. C. F. Denquet at Armidale, N.S.W., I find the following:—

A. ♂ (11½ × 4 mm.) front passes from 1 (+) mm. at base to about 1⅓ mm., at its widest.

B. ♀ (18 × 6 mm.) from 1½ mm. at base to 2 (+) at widest.

Thus in A it would approach the term "parallel" as used by Obenberger, while in B it would be clearly "divergent". I note similar sexual distinctions in other species. In both sexes the abdomen is bispinose and emarginate at the extremity, though this is much obscured and less evident in the female, by the presence of the produced apical sternite and I have noted one species, *C. obscura* Cart., in which the spines are reduced to tubercles.

I have already published (These PROCEEDINGS, 1924, p. 531) my reasons for considering the genus *Neocuropsis* as redundant.

Table of Curis.

1. Elytra unicolorous 2
   Elytra more or less variegated 6
2. Elytra brilliantly metallic 3
   Elytra obscure purple-brown ..... *obscura* Cart.
3. Elytra coppery ..... *corusca* Waterh.
   Elytra metallic green, blue or purple 4
4. Elytra finely punctate-striate, intervals not rugose ..... *spencei* Mann.
   Elytra coarsely punctate, intervals rugose 5
5. Pronotum concolorous, in middle carinate anteriorly, lightly excavated posteriorly ..... *viridicyanea* Fairm.
   Pronotum, medial area violaceous; medial excavation continuous throughout without carina ..... *chloriantha* Fairm.
6. Elytra without raised costae (lines that represent them are traceable) ..... *olivacea* Cart.
   Elytra more or less costulate 7
7. Margins of elytra serrulate, elytra of normal length 8
   Margins of elytra entire, elytra abbreviated ..... *splendens* Macl.
8. Elytra "fusco-aenea" save for marginal coppery vitta 9
   Bright metallic area of elytra limited to basal region ..... *regia*, n. sp.
   Bright metallic area of elytra not limited as above 10
9. Pronotum concolorous, elytral costae prominent, intervals finely punctate ..... *perroni* L. and G.
   Pronotal margins coppery, elytral costae not prominent, intervals coarsely punctate ..... *intercribrata* Fairm.
10. Bright metallic area of elytra limited to base and margins ..... *discoidalis* Blkb.
    Bright metallic area of elytra limited to suture and margins 11
11. Sutural metallic area narrow; elytral punctures sublineate ..... *aurifera* L. & G.
    Sutural metallic area expanded behind, elytral punctures irregular 12
12. Pronotal colours in vittae, hind tibiae normal (narrow) ..... *caloptera* Boisd.
    Pronotal colours not in vittae, hind tibiae wide ..... *yalgoensis* Cart.

Synonymy.

1. *aurifera* L. & G. = *aurovittata* Boh. (typ. comp. Saunders).

2. *caloptera* Boisd. = *dives* Hope (typ. comp. K. G. Blair) = *aurovittata* Kerr. (*nec* Boh.) var. *formosa* Gestro (also det. Kerr.); var. *confusa* Obenb.

3. *splendens* Macl. = *brachelytra* Fairm. = *splendens* Cart. (*nec* Fairm.) = *fairmairei* Cart.

Notes.

C. despecta Fairm. is unknown to me, and has been omitted from my table.

C. chloriantha Fairm. is not a synonym of *spencei* Mann, as stated by Kerremans (*Gen. Ins.*). Two specimens from Western Australia (Coll. Lea and S. Aust. Mus.) are clearly distinct from both *spencei* Mann, and from *viridicyanea* Fairm., as stated in my table, though it is much more closely allied to the latter.

C. corusca Waterh.—A mutilated example of this is in the South Australian Museum from Adelaide. Its author gave no locality.

C. spencei Mann.—I possess a single example of this taken by Mr. H. Giles at the Drysdale River, N. W. Australia.

C. viridicyanea Fairm.—A widely distributed species from various parts of North Queensland (one example is labelled Adelaide in the South Australian Museum). It varies in colour from bright green to blue or violet-blue.

C. splendens Macl.—Through a misidentification my note on this species (These Proceedings, 1924, p. 531) is erroneous. *C. splendens* Macl. = *C. splendens* Fairm., and the superfluous name *fairmairei* Carter must be sunk.

C. perroni L. & G.—A single specimen of this rare insect is in the South Australian Museum, Blackburn Coll., without a legible locality label. It was described from Kangaroo Island.

C. discoidalis Blkb.—The author thought that this was closely allied to *intercribrata* Fairm., but it is abundantly distinct by its sculpture, apart from colour, the margins of pronotum and elytra being coarsely and definitely punctate, while in Fairmaire's species the sides of pronotum are closely rugose and of the elytra very finely punctate.

C. caloptera Boisd. var. *formosa* Gestro.—With a long series before me I find a perfect gradation from the normal to the more brilliantly coloured form that is clearly *formosa* and which appears most often in Queensland examples. I have also specimens from Victoria. *C. confusa* Obenb. cannot be separated from *formosa*. The distinctions stated by this author are, I consider, merely individual or sexual.

Curis regia, n. sp.

♀. Oblong; head golden green, pronotum with wide margins and narrow medial vitta golden green, cyaneous on each side of the latter; elytra chiefly purple with cyaneous gleams, these showing especially on the subobsolete costae; basal margins and the suture near scutellum golden, underside metallic peacock-blue-green, the margins of segments, apex of abdomen, antennae and legs blue.

Head widely and deeply excavate, strongly, not densely, punctate, inner margins of eyes sub-parallel. *Prothorax*: Apex nearly straight, slightly produced at the acute anterior angles, base strongly bisinuate (more so than in *caloptera* Bdv.), sides lightly rounded, widest near middle, thence sub-obliquely narrowed each way, rather more strongly so in front than behind; posterior angles subacute and a little produced, this emphasized by an elongate depression near basal margin; a deep elongate-elliptic fovea at middle, covering basal half, having a fine carina visible at bottom of this, continuous with a smooth medial line on apical half; surface at middle and sides moderately punctate—the punctures more distant towards sides and subobsolete on the convex blue area. *Scutellum* circular, with a longitudinal depression. *Elytra* rather sharply and separately rounded behind, not quite covering body, margins serrated; three unusually faint and nitid costae just apparent, the punctures of intervals moderate near base, soon becoming gradually finer from base to apex, with a perceptible lineate arrangement. Underside moderately punctate, more strongly on prosternal episterna than elsewhere, punctures otherwise very fine and shallow. *Dim.*: 13 × 5 mm.

Hab.—King Plains, North Australia.

A single female example in the National Museum is nearest—though not very close—to *C. caloptera* Bdv., but differs, besides markedly in colour, in the more deeply excavate pronotum with its more strongly bisinuate base, less rounded sides, and the much finer surface punctures, both of pronotum and elytra. In fact it is the most finely punctate of all except *olivacea* Cart., while in its little raised costae it is intermediate between *caloptera* and *olivacea*. ♂ wanting.

Holotype in the National Museum. The name is suggested by its purple elytra as also by its habitat.

Revision of Neocuris *Fairm.*

Since Fairmaire published his Synopsis of *Curis* and *Neocuris* in 1877, a good deal of uncoordinated work has been done. Blackburn has already pointed out (*Trans. Roy. Soc. S. Aust.*, 1887, p. 249) the unsatisfactory diagnosis of *Neocuris* given by Fairmaire, in which the one character, of those mentioned by him, which distinguishes *Neocuris* from *Curis* is the shorter basal segment of the hind tarsi. Other unmentioned distinctions are (*a*) pronotum without medial impression, (*b*) elytra non-striate, rarely with any sign of seriate arrangement of sculpture. Thanks to help from my friends of the British and respective Australian Museums, considerable material is at my disposal, and I have been able to identify with some certainty the majority of recorded species. There are, I find, 38 published names, two by Hope, two by Macleay, eleven by Fairmaire, four by Blackburn, six by myself and thirteen by Obenberger. Of these the following is the result of my inquiry: Species removed to *Pseudanilara*, 3; Synonyms or varieties (as below), 11; total, 14; leaving 24 good species, to which three more are added below, making 27 existing species, of which 25 are tabulated as follows (two, *smaragdifrons* Oben., and *nickerli* Obenb., are omitted as unknown to me):

Table of Neocuris.

1.	Elytra partly yellow	2
	Elytra with metallic impressions	7
	Elytra unicolorous	8
2.	Yellow markings consisting of a transverse medial fascia	*guérini* Hope.
	Yellow markings otherwise	3
3.	Yellow colour pervading whole elytra	*asperipennis* Fairm.
	Apices of elytra dark	4
4.	Dark colour widely invading the yellow area both at base and apex	*ornata* Cart.
	Dark colour of elytra not so	5
5.	Pronotum brown with metallic gleams	*discoflava* Fairm.
	Pronotum green or violaceous	6
6.	Elytral punctures distinct and frequent	*browni* Cart.
	Elytral punctures indistinct and sparse	*doddi*, n. sp.
7.	Elytra atro-violaceous, with three coppery impressions	*fortnumi* Hope.
	Elytra blue with eight golden pubescent impressions	*auro-impressa* Cart.
8.	Pronotum with margins (at least) metallic	9
	Pronotum unicolorous	15
9.	Elytra blue*	10
	Elytra obscure bronze or black	12
10.	Whole, or great part of, pronotum fiery coppery	*thoracica* Fairm.
	Margins only metallic	11
11.	Form wide, subobovate, pronotum rounded at sides, front clearly impressed	*cuprilatera* Fairm.
	Form narrow, subparallel, pronotal sides nearly straight, front not impressed	**gracilis* Macl.
12.	Form rather wide, elytra dark violaceous bronze	*anthaxioides* Fairm.
	Form narrow, elytra black or nearly so	13

13. Elytra black ..... † ? *obscurata* Obenb.
Elytra obscurely bronze or brown 14
14. Form depressed, subopaque ..... †? *carteri* Obenb.
Form subconvex, nitid ..... *pauperata* Fairm.
15. Surface glabrous 16
Surface pilose 22
16. Surface brilliantly metallic 17
Surface dark coloured 20
17. Bicolorous, pronotum green, elytra coppery ..... *dichroa* Fairm.
Unicolorous, green or blue 18
18. Length 8½ mm. (or more), elytra "obsoletissime costulatis", colour peacock-blue ..... *monachroma* Fairm.
Length less, elytra not as preceding, colour generally green 19
19. Length 5-7 mm., colour peacock green (not rarely blue: var. *sapphira* Cart.), head impressed ..... *viridimicans* Fairm.
Length 4 mm., or less, colour golden green, head convex ..... *viridiaurea* Macl.
20. Colour (of pronotum at least) blue-black ..... *fairmairei* Blkb.
Colour (of pronotum at least) bronze 21
21. Length 8 mm., elytra subviolaceous, prothorax converging from base to apex .... † *crassa* Obenb.
Length 4 mm. (or less), elytra concolorous with pronotum, prothorax subparallel ..... *aenescens*, n. sp.
22. Form wide, head clearly impressed, upper surface coarsely punctate, hairs long .. 23
Form narrower, head convex, upper surface finely punctate, hairs short .... *violacea*, n. sp.
23. Colour clear indigo-blue, elytra rugose punctate ..... *coerulans* Fairm.
Colour nearly black, elytra much more closely and simply punctate .. *pubescens* Blkb.

* Colour variable in *gracilis* and *pauperata*; in old examples sometimes nearly black, with the cyaneous tinge faint.

† Hypothetically determined.

Synonymy.

1. *N. ornata* Cart. = *hoscheki* Obenb.

2. *N. browni* Cart. = ? *luteo-tincta* Obenb.

3. *N. cuprilatera* Fairm. = ? *indigacea* Obenb.

4. *N. gracilis* Macl. = *soror* Fairm. = ? var. *atra* Obenb. = ? var. *ignota* Obenb. = *oblongata* Obenb. = var. *lepida* Obenb.

5. *N. anthaxioides* Fairm. = var. *livida* Cart.

6. *N. viridimicans* Fairm. = var. *sapphira* Cart.

7. *N. coerulans* Fairm. = ? *pilosula* Obenb.

8. *Pseudanilara* (*Anthaxia*) *cupripes* Macl. = *N. dilataticollis* Blkb.

9. *Pseudanilara* (*Anthaxia*) *purpureicollis* Macl. var. *nigra* Macl. = *N. nigricans* Blkb.

10. *Pseudanilara* (*Neocuris*) *pilosa* Cart. = *N. pilosa* Cart.

The first name holds good in each case.

Notes on Synonymy.

With regard to (1) and (2), I understand that Dr. Obenberger was unaware of my paper (These Proceedings, 1912, pp. 509-510 with text-fig. of *N. ornata*) when he published his first two (above) in *Col. Rundsch.* 1917; but in *Sbornik Ent. National Museum of Prague*, 1923, he has described no less than eleven new species, in addition to naming two new varieties, these eleven descriptions *containing no single word of reference to recorded species.* In small insects, difficult to determine from description—even when it is given in some detail—a note of comparison with its nearest allies is highly desirable, and would serve to show the author's knowledge of such species. Dr. Obenberger, however, gives himself away at the beginning of his first description (*N. pilosula*) by the state-

ment, "Differs from all known species by her pilose body", when three known species have a similar clothing to that described by him, of which in two cases, *pubescens* Blkb. and *pilosa* Cart., this clothing is indicated in the name; while in *coerulans* Fairm., there is an unfortunate omission in the author's description—though the fact of its pilose clothing is well known, and is shown in an example sent from the British Museum. Except for the words "head without median impression" the description of *pilosula* would fit *coerulans* Fairm., or *pubescens* Blkb., and this is a variable character in some species.

I have hypothetically determined three of Obenberger's species, namely, *carteri*, *obscurata* and *crassa*, from the material under examination, while two are unknown to me, *smaragdifrons* and *nickerli*. I believe the remaining six to be synonyms or varieties of recorded species.

N. guérini Hope var. *subtilis*.—Nothing in his description of this is inconsistent with quite usual forms, included in the descriptions of Saunders (*Trans. Ent. Soc. Lond.*, 1868, p. 20) or of Fairmaire, and the name *subtilis* is superfluous.

N. indigacea Obenb.—The description of this clearly applies to a species that is moderately common around Sydney and the Blue Mountains, that I have long ago determined as *cuprilatera* Fairm., though the habitat of this is stated by its author as King George Sound, W.A. There is nothing like it amongst the W.A. material before me.

(5). Allowing for considerable variation in size, the two examples of *N. livida* Cart., in the Melbourne Museum are conspecific with *N. anthaxioides* Fairm. (as determined by C. O. Waterhouse and Blackburn) and my name should not be retained, except as a variety. The five other examples before me agree with Fairmaire's dimensions, 4-6 mm. long. Both examples of *livida* are 8 mm. long.

(8, 9, 10). I have already published the synonymy of *N. dilataticollis* Blkb. with *Pseudanilara cupripes* Macl. I now find from a specimen, compared with type, that *N. nigricans* Blkb., is identical with *Ps. purpureicollis* var. *nigra* Macl. *N. pilosa* Cart., is also clearly a *Pseudanilara*, distinct from *P. cupripes* in colour, clothing and sculpture and must be known as *Pseudanilara pilosa* Cart.

There is considerable variability in colour and size. With regard to colour Fairmaire's group I.*b* is defined by "Prothorax cupreo- aut cyaneo- aut viridi-marginatus". But amongst these are species like *pauperata* Fairm., in which the "plus minusve" of his description is amply justified, since this common South Australian and Victorian species shows every variety from those in which this character is clear to others where only the faintest gleam is discernible. Again *N. gracilis* Macl., shows colour variation from "cupreo" to "viridi-marginatus" that is associated with its wide distribution from North Queensland to Sydney; and which Fairmaire stated of *soror*, the Sydney form, which cannot be distinguished from the type of *gracilis* from Gayndah, Q. The variation from metallic green to blue or violet is common in this genus as with *Melobasis* and *Stigmodera*. I did not sufficiently allow for this when describing *N. sapphira*, which name must be sunk, as below. In more than one species I have seen variations of size from 4 mm. to 7 mm. (in one case to 8 mm.) long. The following show the distribution of the species from examples examined:—

guérini Hope.—N. S. Wales, S. Qld., and S. Aust.

fortnumi Hope.—Vict., and S. Aust.

gracilis Macl.—Sydney, N.S.W., to Cairns, N. Qld.

viridiaurea Macl.—N. W. Aust.

asperipennis Fairm.—S. Aust., a long series from Oodnadatta (Blackburn).

thoracica Fairm.—S. Aust., W. Aust., and Western N. S. Wales (Bogan R.).
discoflava Fairm.—Perth and Fremantle, W. Aust.
cuprilatera Fairm.—N. S. Wales.
anthaxioides Fairm.—S. Aust. to W. Aust.
pauperata Fairm.—Vict., and S. Aust., W. Aust., and Western N. S. Wales (Bogan R.).
dichroa Fairm.—S. Aust.; and W. Aust.
monochroma Fairm.—North Vict., and S.W. of New South Wales (Young).
viridimicans Fairm.—W. Aust. (in Geraldton district, Mrs. G. A. Waterhouse found this in several instances inside an "everlasting" flower, *Helichrysum* sp.).
coerulans Fairm.—N. S. Wales, Vict., and Qld.
pubescens Blkb.—S. Aust. to W. Aust (1 ex. Qld.).
fairmairei Blkb.—S. Aust.
ornata Cart.—S. Qld.
browni Cart.—Cue and Southern Cross, W. Aust.

Of the rest the material is more scanty. *Neocuris* are not numerous in collections and are seldom found otherwise than in single examples, generally on flowers, especially of *Eucalyptus* and *Leptospermum*. The following are new species:

NEOCURIS DODDI, n. sp.

Ovate, head, pronotum and scutellum violaceous blue, elytra yellow, with a narrow basal and sutural border shoulder spot, apices (widely) and apical half of lateral margins violet-blue; underside and appendages dark blue.

Head wide, impressed and lightly canaliculate on front, strongly and closely punctate. *Prothorax* widest at base, sides obliquely—scarcely arcuately—narrowed to apex, apex arcuate, anterior angles (seen from above) a little advanced, base bisinuate, posterior angles subrectangular, an indistinct triangular impression at base; disc very nitid with sparse shallow punctures at middle, round, large, close punctures at sides. *Scutellum* small. *Elytra* as wide as pronotum at base, separately rounded and finely denticulate at apices, with deep triangular depression near shoulder; scalose-punctate, the punctures somewhat transverse, in places showing faint signs of a seriate arrangement; underside clearly punctate, clothed with decumbent silvery hair. *Dim.*: 5·5 × 2·5 mm.

Hab.—S. Queensland; Chinchilla (Mr. A. P. Dodd).

A single specimen, kindly given me by its captor, shows an affinity with the Western Australian species *N. browni* Cart., from which it differs by its concolorous and nearly straight-sided pronotum, besides other colour distinctions. The deeply excavate subhumeral depression is a marked character. A second example has (since writing the above) been shown me by Mr. J. Armstrong from Bogan River, N.S.W., and a third example from Warra, S. Queensland, is in the National Museum.

Type in Coll. Carter.

N.B.—I find that I described *N. browni* as having the elytra finely punctate-striate, but (as also in the above species) the punctures only very vaguely show any seriate arrangement and are nowhere striated.

NEOCURIS AENESCENS, n. sp.

Oblong, moderately convex, dark bronze above, elytra tending to purple or coppery towards apex; head and antennae green or coppery, legs and underside purple-bronze; entirely glabrous and nitid.

Head wider at eyes than apex of pronotum, front not impressed, slightly diverging behind; closely and evenly punctate. *Prothorax*: Apex and base bisinuate, sides nearly straight, very lightly narrowed from base to apex, densely (contiguously for the great part) covered with punctures larger and more shallow than those on head, the apical border metallic, like the head. *Elytra* of same width as prothorax at base, shoulders with an elongate swelling, a light depression inside this, sides a little sinuate, with a wide incurved bay behind shoulders, apices separately, obtusely rounded, their margins serrulate, surface irregularly scalose-punctate; underside lightly punctate. *Dim.*: 4 (—) mm. long.

Hab.—N. S. Wales: Bogan River (Mr. J. Armstrong).

A rather narrow, convex little species, without any tendency to metallic side margins to pronotum. Nearest to *pauperata* Fairm., but without a sign of frontal impression, and more convex than that species besides colour differences.

Holotype in Coll. Carter.

Neocuris violacea, n. sp.

Elongate, oblong and depressed; above uniformly violaceous, clothed with short, rather dense, upright white hair; underside nearly black, femora and margins of abdominal segments violet, oral organs, antennae and tarsi castaneous; the apical segments of antennae pilose.

Head, at eyes not as wide as apex of pronotum, with a short sulcus only at extreme vertex, dotted closely with very small punctures, each bearing a short upright hair. Eyes rather prominent, the frontal interspace diverging in front and behind them. *Prothorax* short and wide, apex nearly straight, lightly produced at the depressed, obtuse anterior angles, base lightly bisinuate, posterior angles obtuse, sides well rounded, widest behind middle, thence subsinuate behind, and arcuately narrowed to the front; disc closely dotted with small piliferous punctures. *Scutellum* small, subcircular. *Elytra* wider than prothorax at base and about four times as long, sides subparallel (very little compressed in middle), separately rounded behind and minutely crenulate at hind margins; closely covered with small round punctures; underside with more distant and shallow punctures and bearing more sparse recumbent hairs. *Dim.*: 5 (+) mm. long.

Hab.—N. S. Wales: Nambucca River (H. J. Carter).

I took a single ♀ example near Bowraville. It can only be confused with *coerulans* Fairm., and *pubescens* Blkb. In both of these the form is wider, the head concave, the elytra more convex and the whole surface much more coarsely punctate with longer hairs, and the antennae are metallic. It is in form somewhat like a species that I have provisionally determined as *obscurata* Obenb. ♂ wanting.

Holotype in Coll. Carter.

Trachys.

I have before me 40 examples of the genus *Trachys* that belong to, at least, seven distinct species, allowing for some variation. These forty vary in size from 2 mm. long to slightly more than 3 mm. long. The chief distinctions lie in ground colour, presence and pattern of pubescent clothing, outline and, especially, the form of the head. In the last the anterior outline may be nearly straight, or deeply arcuately excised, with varying width. All have the sublateral carina on the elytra except *T. blackburni* Kerr., of which a type example has been sent

from the British Museum (Kerremans labelled *all* his examples of a new species "type").

Eight names have been published for Australian species, of which the earliest was *T. australasiae* Gestro in 1877. It is curious to read that both Van d. Poll and Macleay claim their respective species (*frenchi*—1887 and *australis*—1888) to be the first Australian species to be described, yet Gestro's seems to be quite distinct from those later described in having its "prothorax vittis tribus" in combination with the other characters mentioned. I have determined a single example from the South Australian Museum as *T. australasiae* Gestro as being (*a*) the only specimen before me that can be fitted to Gestro's description, (*b*) also taken at Somerset, C. York (C. T. McNamara), Gestro's locality.

Of the other seven names, I have examined types or examples that have been compared with types of five, viz. *australis* Macl., *blackburni* Kerr., *frenchi* V. d. Poll., *nigra* Macl., and *socialis* Lea, while I have hypothetically determined a unique from Somerset as *pauperula* Kerr., though this species is said to come from New South Wales. This determination, with a query, is preferable to describing as new a unique example that is at least very near to Kerremans' species. I have, with less doubt, determined five examples (three from Somerset in the South Australian Museum and two, from Cape York and Cairns respectively, in the Macleay Museum) as *T. albo-picta* Kerr., a species described as from New Guinea but likely to occur on Cape York.

Synonymy.—*T. frenchi* V. d. Poll. = *T. nigra* Macl. = ? *T. hackeri* Obenb.

This synonymy seems certain. An example of *frenchi* from Kuranda, Q. (compared with type by its author) has been sent me from the British Museum and is identical with the unique type of *nigra* in the Macleay Museum. Two other specimens in the Macleay Museum from Cairns are also conspecific, though of a rather brighter metallic ground colour. This character agrees with V. d. Poll's description. It is probable that the darker surface of *nigra*, as also of the British Museum example of *frenchi*, is due to immersion in spirits. *T. hackeri* Obenb., is vaguely described, the only reference to the anterior outline of head being (*a*) "front between eyes rather strongly attenuate anteriorly" and (*b*) "without distinct median *impression*". Interpreting the latter to mean that the anterior outline is nearly straight, I find this character true of only one of my seven species, namely, *T. frenchi*—and the remainder of Obenberger's description is in agreement with the example of V. d. Poll's insect before me.

The seven species may be tabulated as follows:—

1. Species having elytra without sublateral carina ..... *blackburni* Kerr.
   Species having elytra with sublateral carina 2
2. Head with front lightly arcuate, almost straight ..... *frenchi* V. d. Poll.
   Head with front more or less deeply, and arcuately excised 3
3. Pronotum with trivittate pubescence ..... *australasiae* Gestro.
   Pronotum without such pubescence 4
4. Ground colour of upper surface golden or brassy* ..... *australis* Macl.
   Ground colour of upper surface purplish or bronze 5
   Ground colour of upper surface black or nearly so ..... ? *albo-picta* Kerr.
5. †Size larger, head narrower ..... *socialis* Lea.
   Size smaller, head wider and less deeply excised ..... *pauperula* Cart. (? Kerr.)

* Four examples from Townsville (F. P. Dodd) in the British Museum collection are apparently only a colour variety (ground colour a darker bronze) of *australis* Macl., which I should hesitate to describe as distinct.

† The punctures arranged in lines, on the elytra, are much larger than in the case of *australis* Macl., in which they are *very* fine; otherwise some examples of *socialis* are like a large *australis*.

Tenebrionidae.

Synonymy.—Leichenum seriehispidum Mars. = *L. variegatum* Klug. = *Endothina squamosa* Cart.

In my "Check-list of Australian Tenebrionidae" (*Aust. Zool.*, 1926) I stated (p. 123) the possibility of *Endothina* being congeneric with *Leichenum*. Mr. K. G. Blair now confirms this, after an examination of specimens I sent him from Cairns. The geographical distribution of this sea-beach dweller is very remarkable, in Australia occurring, at least, from Sydney to Cairns; *L. seriehispidum* is from China and Japan, and *L. variegatum* was described from Madagascar. The name *Endothina* thus drops out.

Microcrypticus (Platydema) scriptipennis Fairm.—Four examples of this, taken by Mr. F. H. Taylor, at Townsville, Q., have been determined by Mr. K. G. Blair. The wide distribution of this insect is even more remarkable than that of *Leichenum*. The type is from E. and W. Africa, while there are examples in the British Museum from India, Ceylon, Java, Borneo, Celebes, New Guinea, West Indies and Brazil.

Saragus confirmatus Pasc. = *S. opacipennis* Macl. Specimens of the latter, determined by me, have been compared with Pascoe's type by Mr. Blair.

In each of the above the first name takes precedence.

Notocerastes tricornis, n. sp.

Oblong, opaque chocolate-brown, variegated by an adpressed clothing of paler colour, appendages more or less concolorous brown.

Head with two small triangular horns at sides of clypeus, formed by a subvertical extension of antennal orbit, and a frontal horn transversely triangular between the eyes; eyes large and prominent, antennae stout, pilose, extending to base of prothorax when at rest; segments 1-2 cup-shaped, 1 wider than 2, 3-8 widely oval, 3 longer than 4, 9-11 much wider than preceding, forming a loose club. *Prothorax*: Apex vertically and horizontally sinuate, anterior angles wide and depressed, apical margin rising in middle towards two parallel crests and hollowed between these; base lightly sinuate, widest near front, here rather widely rounded, thence lightly narrowing to the dentate but obtuse hind angles; lateral margins irregularly crenate, rather widely concave within these; disc with surface uneven, clothed with a dense recumbent mat of coarse hair having a transverse tendency except at the two medial ridges near apex, where hairs are arranged longitudinally. *Scutellum* transverse. *Elytra* wider than prothorax at base and about two and a half times as long; shoulders narrowly rounded and prominent; sides parallel, lateral margins only visible from above at apical third, here clearly serrulate; each with four lightly raised costae, the suture also a little raised; between each pair of costae two lines of foveate punctures (in places obscured by derm), the paler clothing occupying a wide basal area, a less wide fascia near apical declivity and irregular patches elsewhere. Underside and legs as in *N. blackburni* Cart. *Dim.*: 6 × 2·6 (approx.) mm.

Hab.—Queensland National Park, MacPherson Range.

I took a single ♂ example in January last by beating the dense foliage at the edge of the scrub. It is certainly conspecific with *N. blackburni* from which it obviously differs in (1) wider and more depressed form, (2) the three-horned head of ♂, (3) the costate elytra. The coarse, pilose derm is similar but more variegated, the antennae are coarser and more strongly clavate, the eyes are larger and the pronotal surface more uneven. Mr. K. G. Blair, to whom I sent

the insect for examination, now suggests the synonymy of *Notocerastes* with *Phaennis*; and the armature of the head of the above species certainly agrees with this suggestion—as also the antennal structure. The clothing of *Phaennis* is quite different, having the long upright hairs characteristic of *Ectyche*, whilst the excised hind part of the pronotum continues the likeness. For the present, therefore, I would retain these genera as separate.

Holotype in Coll. Carter.

ADELIUM ABNORME, n. sp.

Widely oblong ovate; nitid black, tarsal clothing red with white hairs interspersed.

Head finely rugose-punctate, clypeus rounded, not raised nor prominent in front of eyes, antennae not extending to base of prothorax; segments subconic, 3 about as long as 4-5 combined, 9-10 transverse, 11 pyriform, wider and longer than 10. *Prothorax* very transverse, apex and base about equally wide, apex arcuate-emarginate, anterior angles acute, base subtruncate, posterior angles rather squarely dentate, its points directed outward, forming an angle of about 80°; widest behind middle, sides widely rounded, arcuately converging in front, strongly sinuate before hind angle; disc coarsely, irregularly punctate, with close elongate punctures, having slightly rugose boundaries near middle and sides, elsewhere punctures round and contiguous; sculpture continuous to margins, without special foliation; medial channel clearly impressed throughout. *Elytra* considerably wider than prothorax at base, widely oblong (5 × 4 mm.), humeri obtusely rounded, epipleural fold forming sharp ridge; sulcate, the ten sulci irregularly and sparsely punctate; intervals 1-5 convex, 6-8 sharply costate, all intervals strongly punctate; a few larger punctures within the sulci on sides of intervals. Prosternum coarsely punctate, abdomen sublaevigate, post-intercoxal process truncate; postcoxae with 1st segment longer than 4th. *Dim.*: 8 × 4 mm.

Hab.—S. Queensland: Stanthorpe (Mr. E. Sutton).

A single example given me by the above keen local naturalist, shows a small wide species readily determined by its combination of wide form, strongly dentate hind angles of prothorax, and the unusual sculpture of the elytra. This is uniformly sulcate, and devoid of any regular seriate punctures. *A. striatum* Pasc. is the only species in which the sulci are entirely impunctate. *A. violaceum* Cart. has the seriate punctures small and inconspicuous, but is differently shaped and coloured. The black colour extending to the appendages—even to the tarsi, except the clothing—is also unusual.

Holotype in Coll. Carter.

ADELIUM SPINICOLLE, n. sp.

Oval; chocolate-brown, subnitid, oral organs, antennae, tarsi and margins of pronotum reddish.

Head rather coarsely and closely punctate, front depressed, labrum prominent, clypeus rounded, its sides widened and prominent (subangulate) in front of eyes, clypeal groove straight; antennae short, segment 3 not as long as 4-5 combined, 4-10 submoniliform, apical segments little widened, 11 oval. *Prothorax*: Apex arcuate-emarginate, wider than base, its anterior angles sharply dentate and advanced; base lightly bisinuate, posterior angles triangularly dentate, forming an angle of about 75° pointing obliquely outward and backward; sides well rounded, widest at middle, extreme border widely crenate, with from 6 to 8 blunt

spines limiting the crenations; foliate margins rather widely explanate; disc closely rugose-punctate, medial channel deeply impressed throughout. *Elytra* considerably wider than prothorax at base, irregularly striate-foveate, the punctures in first four striae large and irregular, in the fifth and sixth forming large cancellate foveae; the first four intervals widely convex, the fifth more strongly raised than the preceding, the seventh, ninth and the margin forming sharp costae, converging and forming sharp ridges in humeral region. Prosternum with sparse, round punctures, metasternal epimera and epipleurae coarsely punctate; post-intercoxal process widely rounded, legs moderately long, tibiae straight, post-tarsi having first segment as long as fourth. *Dim.*: 10 × 4 mm.

Hab.—Queensland National Park, MacPherson Range (H. J. Carter).

I took a single example under a log on the edge of the rain forest. It is so distinct from its nearest ally as to suggest generic separation, but as this distinction chiefly applies to the spinose-crenate border of the pronotum, it may, for the present, be included in this polymorphic genus. The brown colour may be due to immaturity, which is indicated by its rather soft tissues. The raised parts of surface are very nitid.

Holotype in Coll. Carter.

DYSTALICA ANGUSTA, n. sp.

Oblong, subdepressed; sub-opaque black, antennae and tibiae piceous, tarsi reddish, upper surface and appendages clothed with short, bristly hair; underside of tarsi pilose.

Head granulose and punctate (basal area rugose-punctate), anterior regions granulose, eyes rather round; antennae extending nearly to base of prothorax, segment 3 as long as 4-5 combined, 4-7 subtriangular, 8-10 successively more transverse, 11 pyriform, nearly twice as long as 10. *Pronotum* nearly as long as wide, apex arcuate-emarginate, anterior angles acutely produced, base feebly bisinuate, sides evenly, moderately rounded, scarcely sinuate behind; posterior angles sharply rectangular; disc opaque, densely punctate and bristled, the latter giving a granular appearance and producing a fine fringe at margins, these not at all explanate. *Scutellum* semicircular. *Elytra* subnitid, wider than prothorax at base, shoulders rather squarely rounded, sides subparallel in ♂, slightly obovate in ♀; striate-punctate, the deep striae containing large round punctures, rather closely placed, intervals slightly raised, granulose (where abraded of clothing). Underside opaque, the whole surface closely pitted with large, deep punctures. *Dim.*: 9·5 × 3-3·5 mm.

Hab.—Queensland National Park (Mr. R. Illidge).

Another discovery of the veteran Queensland entomologist, who has kindly sent me a pair. It is a puzzling species to place generically, but its combination of bristly, coarsely punctured surface, somewhat rounded eyes, oblong form and pilose tarsi point to *Dystalica* rather than to *Adelium*, from which it also differs in the longer and less transverse pronotum. It is certainly not a *Brycopia*.

Holotype and allotype in Coll. Carter.

LEPTOGASTRUS WILSONI, n. sp.

Elongate-ovate; dark purple-bronze, subnitid, upper surface moderately clothed with long upright dark hairs.

Head coarsely punctate, eyes oval and rather prominent, antennae moniliform, segment 3 little longer than 4, 7-10 successively widening, 11 pyriform, much

larger than 10. *Prothorax*: Apex subtruncate, base feebly sinuate, anterior angles subacute, as seen from above, but scarcely advanced; widest near middle, sides lightly rounded, narrowed but scarcely sinuate on basal half, posterior angles defined and subrectangular; base feebly sinuate; disc coarsely punctate, medial channel lightly impressed throughout. *Scutellum* minute, scarcely visible. *Elytra* wider than prothorax at base, shoulders rather widely rounded, sides subparallel for two-thirds of their length; striate-punctate, the striae deeply impressed, the seriate punctures large and close, intervals narrow, nearly flat, each with a row of large setiferous punctures placed more widely than the seriate punctures; underside subnitid, glabrous, moderately punctate. *Dim.*: 5 × 1·5 mm.

Hab.—New South Wales; Albury (Mr. F. E. Wilson).

A single example taken by this indefatigable collector is clearly distinct from its congeners by its combination of bronze colour, flat elytral intervals, and defined hind angles to the pronotum.

Holotype in Coll. Wilson.

PODAMARYGMUS, nov. gen. Amarygminarum.

Differs from *Amarygmus* in the abnormally elongate fore legs and their unusual tarsal clothing, the fore legs, including tarsi, when extended, being longer than the insect itself. The fore tarsi are much widened by a dense brush of long stout black hairs. These spring from the underside along the whole length of the segments, the hairs being slightly curled downwards at the tips. The mid and posterior legs as in *Amarygmus*, mandibles notched at apex.

PODAMARYGMUS ALTERNATUS, n. sp.

Ovate, convex, upper surface brilliantly metallic; head and pronotum versicolorous; elytra with 1st, 3rd, 5th and 7th intervals purple, the 2nd, 4th, 6th and 8th golden green; underside and appendages black; mid and hind tarsi rufo-pilose.

Head: Antennae as in typical *Amarygmus*, segment 1 stout, 2 short, 3 nearly as long as 4 and 5 combined, 8-11 enlarged. Eyes very close, separated by a narrow dissepiment—slightly wider in the ♀ than in the ♂ and widening in front and hind part of eyes. *Prothorax* strongly transverse, apex subtruncate, base feebly bisinuate, sides arcuately narrowed from base to apex with a narrow border continuous along apex; disc with fine sparse punctures, sometimes with a transverse linear impression near base. *Scutellum* triangular, finely punctate. *Elytra* striate-punctate, the punctures sublatent in well impressed striae, intervals moderately convex, sublaevigate, a few minute punctures discoverable thereon, the second much narrower than the first or third, underside laevigate. *Dim.*: ♂, 7 × 4 mm.; ♀, 8-9 × 5 mm.

Hab.—Malaya: Kuala Lumpur and Penang (Mr. A. M. Lea and party).

Four examples (1♂, 3♀) were amongst a collection of Tenebrionidae sent by Mr. Lea for examination.

Holotype and allotype in South Australian Museum.

Cistelidae.

ALEMEONIS RUFO-VITTIS, n. sp.

♂. Black; the mandibles, palpi, three basal segments of antennae, tibiae, tarsi (except the lamellae) and a sub-lateral vitta extending from shoulders to apex of

elytra (but not quite reaching extreme margin) castaneous; upper surface rather thickly clad with silvery upright hair, especially on apical half of elytra.

Head closely and strongly punctate, eyes large and prominent, separated by a space of the diameter of one eye; antennae with segment 1 stout, 2 short, 3 long and subcylindric, 4-10 elongate triangular, of equal length but successively wider at apex, 11 at least as long as 10, finely lanceolate. *Prothorax* rather wider than head, and a little wider than long, apex and base truncate, sides parallel, anterior angles rounded off, posterior rectangular; disc evenly and rather closely punctate and pilose; medial line indicated by a depression terminating near base in a small fovea. *Scutellum* transverse, triangular, punctate. *Elytra* considerably wider than prothorax, widest at shoulders, thence very lightly attenuated to a sharply acute apex; striate-punctate, the rather wide and deep striae containing punctures that crenulate the sides of the wide and lightly convex intervals; the latter each with an irregular row of unequally placed punctures; the castaneous colour of vitta irregularly spreading over the apical area. Underside less pilose than above; mid-tarsi lightly bowed, post-tibiae hollowed and excised near middle; post-tarsi with basal segment as long as the rest combined. *Dim.*: 10 × 2·5 mm.

Hab.—Victoria: Ferntree Gully (F. E. Wilson).

A single male specimen is readily distinguished from its nearest ally, *A. paradoxus* Cart., by the castaneous vitta of the elytra, the pale tibiae and dark femora, the pale tarsi and black lamellae. I have not cared to remove it from the card on which it is gummed to examine the underside more closely.

Type in Coll. Wilson.

Chromomoea major, n. sp.

Head and pronotum piceous, elytra and underside red, the former somewhat obfuscate near apex, appendages red, antennae (partly) and knees sometimes infuscate; lamella on penultimate tarsi black; above and below finely pubescent.

Head and pronotum with very fine, close, uniform punctures; eyes distant, not prominent, antennae moderately slender, segments subtriangular, 3 scarcely longer than 4, 4-10 subequal (or very slightly diminishing outwards), 11 shorter than 10. *Prothorax* nearly squarely cylindric—though appearing longer than wide—very slightly narrowed and rounded at the anterior angles—apex and base truncate; medial impression well marked at base, traceable throughout. *Scutellum* subquadrate. *Elytra* wider than prothorax at base and four times as long, sides parallel for the greater part; striate-punctate, the punctures in striae not uniseriate but rather confusedly poly-punctate; intervals convex and rather finely punctate and, where not abraded, clothed with pale recumbent hair; underside more strongly pubescent and finely punctate; post-tarsi having first segment much shorter than the rest combined. *Dim.*: 13 × 3·5 mm.

Hab.—New South Wales: Wahroonga and Bodalla (H. J. Carter).

This species is not uncommon, but has been confused—at least by myself—with *C. rufescens* Bates. I have, however, a cotype of Bates's species which shows clear distinction; *rufescens* being smaller (9-9½ mm. long), with narrower antennae and uniseriate punctures in the elytral striae. It is separated from *C. oculata* Cart., by its narrower head and less prominent eyes and from *C. picea* Macl., by its convex elytral intervals. The black tarsal lamellae are characteristic. The two examples before me are females.

Type in Coll. Carter.

HOMOTRYSIS RUFIPILIS, n. sp.

♂. Elongate, subparallel, nitid black, pilose; palpi, apical part of antennae and tarsi reddish; whole surface rather thickly clad with upright red hair—this shorter on under surface.

Head and pronotum closely, uniformly and strongly punctate, eyes large and prominent, separated by a space equal to half the diameter of one; antennae linear, segments 3-11 subequal, scarcely at all widened at their apices, 11 not wider than 10. *Prothorax*: Apex slightly produced in middle, base truncate; widest in front of middle, thence widely rounded anteriorly, slightly narrowed without sinuation posteriorly; hind angles subrectangular; a narrow medial impression on basal half and two small basal foveae. *Elytra* considerably wider than prothorax at base; shoulders rather squarely rounded, sides parallel for the greater part; striate-punctate, the seriate punctures rather large and close, intervals lightly convex and strongly setiferous. Underside moderately punctate, the sternal area more strongly than the abdomen; fore tibiae dentate on inside near middle; subcircular forcipital sexual appendage apparent. *Dim.*: 10 × 3 (+) mm.

Hab.—N. Queensland: Watton (Mr. F. H. Taylor).

A single ♂ recently sent me by Mr. Taylor can, I think, only be confused with *H. nigricans* Hope, in being comparatively small, black, nitid and hairy; but *nigricans* has the pronotum widest at base, with subacute hind angles, the elytra more oval, little wider than the prothorax at base, with a different sculpture and the protibiae of ♂ undentate.

Holotype in Coll. Carter.

HYBRENIA ANGUSTICOLLIS, n. sp.

♀. Black, sub-nitid, glabrous, oral organs and labrum red; underside and legs reddish-brown, tarsal clothing red.

Head unusually elongate, densely and finely punctate, eyes prominent, separated by about the width of half the diameter of one eye; front between eyes to vertex deeply sulcate; antennae elongate, segments lineate, 3 much longer than 4, 4-11 subequal. *Prothorax* little wider than head, moderately convex, apex a little produced in middle, base subtruncate, widest in front of middle, anterior angles depressed and rounded, posterior rectangular; disc strongly and closely punctate, medial line rather widely and strongly impressed throughout; a transverse depression near base. *Elytra* much wider than prothorax, sides subparallel; striate-punctate, the deep striae containing close, subcancellate, rather small punctures, intervals impunctate, strongly but irregularly convex, the first three especially convex on basal half, sternal area coarsely, abdomen more finely but distinctly punctate, legs elongate. *Dim.*: 15 × 5 mm.

Hab.—Queensland: Townsville (F. H. Taylor).

A single female sent by Mr. Taylor, is an ally of *H. angustata* Macl., and *H. subsulcata* Macl., in its elongate, parallel form, but is distinguished from the former by its sulcate and less nitid pronotum and the much finer punctures of the elytral series. From both it is distinguished by its sulcate head and the unusually narrow prothorax as compared with the elytra.

Holotype in Coll. Carter.

HYBRENIA YEPPOONENSIS, n. sp.

♀. Black, nitid, with short sparse pubescence; underside, femora, oral organs reddish, antennae brown.

Head and pronotum closely and strongly punctate, eyes large and prominent; separated by a distance of about the diameter of one eye; antennae having 3 longer than 4, thence to 10 subequal, each enlarged at apex, 11 narrowly lanceolate. *Prothorax* convex, apex and base truncate, sides parallel on basal half, rounded near apex, posterior angles slightly produced and subacute; disc evenly punctate, with two gentle depressions at base near angles. *Elytra* obovate, moderately convex, wider than prothorax at base, sides gradually widening to apical third; striate-punctate, the striae narrow and deep, containing close, small, rather elongate punctures; intervals nearly flat except near base, with large punctures rather closely placed, the interstitial punctures gradually smaller towards apex; third interval narrower than the rest. Sternal area strongly punctate, abdomen with light shallow punctures. *Dim.*: 14 × 5·2 mm.

Hab.—Queensland: Yeppoon (H. J. Carter).

I took four examples (all ♀) in November, 1924. It is nearest in general appearance to *H. vittata* Pasc. var. *concolor*, but may be distinguished by its more convex pronotum and strongly punctate pronotum and elytra as also by its widely spaced eyes. ♂ wanting.

Holotype in Coll. Carter.

THE AUSTRALASIAN SPECIES OF THE GENUS *NEMOPALPUS* (PSYCHODIDAE, DIPTERA).

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(*Communicated by I. M. Mackerras.*)

(Two Text-figures.)
[Read 27th June, 1928.]

The remarkably generalized group of Diptera that includes *Nemopalpus* Macquart has been represented hitherto in the Australasian Region only by *Nemopalpus zelandiae* Alexander, found in both islands of New Zealand. The discovery of an undescribed species of the same genus in New South Wales is thus a matter of great interest. The fly was included in collections of crane-flies sent to me by Mr. William Heron and was taken on the Dorrigo Plateau where the collector has made so many discoveries of unusual insects. I am greatly indebted to Mr. Heron for his kind interest in collecting specimens of Tipulidae and related groups.

Historical.

Tillyard (1926) says of *Nemopalpus*: "This genus, placed by some authors in Tanyderidae, unites that family with the Psychodidae, and is probably one of the oldest existing types of Diptera". This concise statement of facts gives us a clear idea of the essentials of the case.

The first species of *Nemopalpus* (spelled *Nemapalpus* in the original), serving as genotype, is *N. flavus* Macquart (1838*a*, 1838*b*) from the Canary Islands. The fly appears to be a very rare one. Loew (1845) and Eaton (1904) evidently possessed additional material, while Becker (1908) who secured a specimen on La Palma, gave a detailed description, with figure. Dr. Elias Santos Abreu (*in litt.*, June, 1924) tells me that during his long residence on the islands he has secured but a single badly preserved specimen, that continued search has revealed no further material, and that he is now inclined to believe that the species is extinct. In any case, the fly, like virtually all of its known relatives, must be held as being excessively rare.

Meunier (1905) proposed the genus *Palaeosycorax* for the Baltic Amber species, *tertiariae* Meunier. This genus is now placed in the synonymy of *Nemopalpus*, as is *Nygmatodes* Loew (1845). Edwards (1921) described a second species from the Baltic Amber as *N. molophilinus*. Alexander (1921) described the New Zealand species, *N. zelandiae*. Tonnoir (1922) summarized our knowledge of the group and described a new species, *N. pilipes*, from Paraguay.

Alexander (1920) proposed the second genus, *Bruchomyia*, for the single known species, *B. argentina* Alexander, of the Argentine.

Systematic Arrangement of Nemopalpus *and allies.*

The curiously annectant nature of *Nemopalpus* and *Bruchomyia* is best shown by the systematic positions assigned to the group by the various authors. Macquart (1838*a*, 1838*b*) placed the genus *Nemopalpus* in the Psychodidae. Eaton (1904) placed it in the subfamily Phlebotominae, a course in which he was followed by Tonnoir (1922). Alexander (1920) proposed a new subfamily group, the Bruchomyinae, placing it in the Tanyderidae, in which course he was followed by Cole (1927). Edwards (1921) proposed the new group Nemopalpinae to receive *Nemopalpus*, *Palaeosycorax* and *Bruchomyia*. Crampton (1925) elevated the group to family rank, the Bruchomyidae, later (1926*a*) reducing it to subfamily rank, Bruchomyinae, in the Psychodidae.

As above stated, these diverse assignments of *Nemopalpus* and allies indicate clearly the annectant character of the group. The Oligocene genus of Tanyderidae, *Macrochile*, is another type that must be placed far down in the series (Crampton, 1926*b*) and there can be no reasonable doubt but that this genus and *Nemopalpus* have sprung from some common ancestral type in late Mesozoic times, the former leading to the remaining and higher Tanyderidae, the latter to the more specialized groups of Psychodidae. The actual relationship of *Nemopalpus* and *Macrochile* is much closer than is shown on paper and I know of no other case in the Nematocera where so close a relationship exists and yet requires the respective genera to be placed in different families of flies.

The thoracic morphology of *Nemopalpus* and *Bruchomyia* has been described and figured by Crampton (1925, 1926*a*). The venation has been shown by Becker (1908), Edwards (1921), Alexander (1920, 1928), Tillyard (1926) and Tonnoir (1922). The general appearance of the flies of this subfamily is shown by Alexander (1920, 1928) and Tillyard (1926). The structure of the genitalia by Tonnoir (1922) and Cole (1927).

Key to the Subfamilies of Psychodidae.

1. Radial sector, Rs, with four branches 2
   Radial sector, Rs, with three branches ..... TRICHOMYINAE.
2. Distal section of vein Cu_1 elongate, extending generally parallel to vein M_4, cell M_4 at wing-margin approximately equal in width to cell M_3; cell Cu sometimes very wide, exceeding cell M_1 ..... PSYCHODINAE.
   Distal section of Cu_1 short to very reduced, longest in *Bruchomyia*; cell M_4 at wing-margin always wider than cell Cu, usually very wide 3
3. Rs pectinately four-branched, R_1 being captured by the upper fork of the sector; mouthparts of female elongate, formed for blood-sucking .... PHLEBOTOMINAE.
   Rs dichotomously four-branched, R_{2+3} and R_{4+5} being present; mouthparts normal, not formed for blood-sucking ..... BRUCHOMYINAE.

In some species of *Phlebotomus*, such as *P. signatipennis* Newstead, cell R_2 is so reduced in size as to presage its total loss by fusion to the wing-margin of veins R_2 and R_3. It is very curious and suggestive that in the Phlebotominae the anterior branch of the posterior fork of the primitively dichotomous sector should have been captured by the upper fork, quite as in three tribes of the Limoniine Tipulidae.

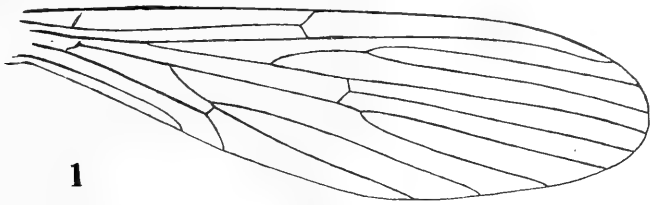
Key to the Genera of the Bruchomyinae.

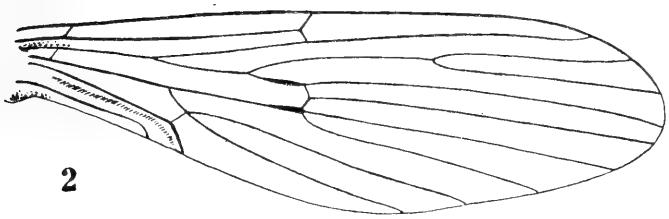
1. Antennae with 30 segments; distal section of vein Cu_1 long, approximately as long as the basal section ..... *Bruchomyia* Alexander.
   Antennae with 16 segments; distal section of vein Cu_1 short, curved strongly to the anal margin ..... *Nemopalpus* Macquart.

Key to the Australasian Species of Nemopalpus.

1. General coloration of the body dark brown, with chiefly dark setae; thoracic pleura dark with a broad pale yellow dorsal stripe; wings without black setae; R_{2+3} relatively short, less than one-half R_2 alone (Fig. 1) ..... (New South Wales) *N. australiensis*, n. sp.

General coloration of the body reddish fulvous, the setae concolorous; thoracic pleura uniformly dark fulvous; wings with scattered black setae on the basal half, including a larger area near the fork of M; R_{2+3} elongate, nearly as long as R_2 alone (Fig. 2) ..... (New Zealand, both islands) *N. zelandiae* Alexander.





Text-figures 1, 2.—Wing-venation of *Nemopalpus*.
1. *Nemopalpus australiensis*, n. sp.
2. *Nemopalpus zelandiae* Alexander.

NEMOPALPUS AUSTRALIENSIS, n. sp.

General coloration of mesonotum dark brown, the posterior sclerites more yellowish; pleura brownish-black with a dorsal pale stripe that widens out behind; wing greyish-yellow, densely clothed with long trichiae, the costal fringe more cinnamon-brown; R_{2+3} only a little longer than R_{4+5} and less than one-half the length of R_2 alone.

Female.—Length about 3·5 mm.; wing, 4·2 mm.

Rostrum brown, the palpi pale brown, not conspicuously elongated. Antennae yellow; flagellar segments elongate-cylindrical, with very long brownish-yellow verticils. Head brownish-yellow, darker medially, with very long and conspicuous setae, shorter and more yellowish in front, longer behind.

Posterior pronotum light yellow. Mesonotum dark brown, with very abundant and conspicuous erect pale setae; posterior sclerites of mesonotum passing into testaceous yellow, this including the scutellum, lateral portions of the postnotal mediotergite, most of the pleurotergite, the metanotum, and the dorsal portion of the pteropleurite. Pleura brownish-black, the dorso-pleural region and the more dorsal pleurites pale yellow, as above described. Halteres dusky, the base of the stem pale yellow. Legs with the coxae and trochanters obscure yellow; remainder of legs pale brown, densely clothed with dark setae. Wings subhyaline

to greyish-yellow, the veins with dense fringes of long trichiae, the costal fringe very dense, bright cinnamon-brown, the apical and posterior fringes more yellowish-brown. Venation (Fig. 1): Sc relatively short, Sc_2 apparently ending about opposite one-third the length of R_{4+5}; R_{2+3} relatively short, considerably less than one-half R_2 alone and only a little longer than R_{4+5}; cell M_1 short-petiolate; m-cu on M_4 just beyond its base. Veins R_{4+5} and M_{1+2} not incrassated as in *zelandiae*.

Abdomen brownish-black, with long scattered yellow setae. Ovipositor consisting of two pale yellow, highly compressed, spatulate blades, with a dense brush of dusky setae immediately beneath their origin.

Hab.—New South Wales.

Holotype, ♀, Brooklana, Eastern Dorrigo, altitude about 2,000 feet, along a stream, November 5, 1927 (Wm. Heron); in the author's collection.

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NOTES ON AUSTRALIAN DIPTERA, No. xiv.

By J. R. Malloch.

(Communicated by I. M. Mackerras.)

[Read 27th June, 1928.]

In connection with the presentation of this series of papers I may at this time be permitted to make a brief statement.

The work was originally undertaken at the request of the late Dr. Eustace W. Ferguson, and was intended as an aid to him in his biological work in Australia. With the passage of time, however, the scope of the project was broadened to include practically all the Cyclorrhapha except the Syrphidae and some related families. The amount of time which I can devote to Australian Diptera is but small, being but a fraction of my leisure time and no portion of my official time is given to them. As my leisure time only can be devoted to systematic work on Diptera, and my studies on the latter include those on material from all over the world, and that time is further cut into by work upon Hemiptera and Hymenoptera, it can be seen that papers on Australian Diptera must form but a minor part of my output on systematic entomology, and that they can under the present circumstances not be monographic, and certainly not so thorough as I would like them to be. In addition to lack of time, one must also consider the paucity of material and lack of field knowledge of same.

I have thus been compelled to adopt a quite conservative course and it is but seldom that I have ventured to present data upon families other than those I have had a good representation of, even when such data might be used in the classification of Australian forms, unless I considered it absolutely necessary that such data, usually previously unpublished, should be made available to Australian students of Diptera. One case in point is to be found in the remarks on the family Asilidae presented herein. The literature on Diptera is increasing very rapidly and many of the old works are both rare and expensive while some of the more important papers on the order appear in magazines or other publications that are not readily procurable in Australia. Consequently many students find it impossible to consult important papers dealing with the groups in which they are interested, and frequently lacking a knowledge of extralimital forms formulate schemes of classification which are not tenable when the world's fauna is considered. This statement applies equally well, of course, to students similarly situated in any part of the world.

My own knowledge of Diptera is not as extensive as I would have it, but my facilities for study of material, and the available library facilities, are greater than they are with most students so I have presumed to express in a few cases ideas that appear to me to be worth consideration in attempting to classify Australian flies.

It is not to be assumed that the genera of many families are better known in South America, Africa, or the Orient, than they are in Australia, and though I

have before me a published paper which on the face of it presents a comparative list of the Brachycera of Australia and other faunal regions, I venture to suggest that the day is still far distant when such a presentation can rest upon anything but a very unstable basis.

Family **Asilidae.**

By far the greatest amount of work on Asilid genera has been done by Loew, and the present classification of the family rests largely upon his work which was published in the first two decades of the last half of the nineteenth century. Therefore, if one desires to understand the system in use today, a knowledge of these earlier papers is imperative. But Loew's knowledge of Diptera, extensive as it was, did not include an appreciation of many of the characters recently introduced for the differentiation of genera, and his distinctions are largely based upon the structure of the antennae, head, legs, and wings, with some attention being given to the chaetotaxy of the thorax, and the structure of the genital organs of both sexes.

More recent workers have introduced other characters, and in America the major grouping is based upon the structure of the palpi, whether one-segmented or two-segmented, while just recently in Australia a suggestion has been made to place more importance upon the presence or absence of genital spines in the females than ever Loew cared to suggest. In fact this latter character has been refused recognition as of even subgeneric value by one recent worker in North America.

Unquestionably all of these characters have a greater or less value as indices to relationships, but the use of any one of them exclusively as a distinctive criterion will not produce a perfect classification. I do not believe, of course, that an absolutely perfect classification is attainable, but the application of the standards referred to results in some incongruous assignments of genera which may possibly be avoided, I think, by accepting other characters as criteria for group purposes.

The palpi are not invariably segmented in accordance with the assignments of Williston in North America, and I find that in many cases the student attempting to make use of the character would be in doubt whether to consider the raised base or pedicel of the palp as a segment or not. The aristae are so various that any attempt to segregate subfamilies on the basis of their structure is impossible because of the exceptions to any rule adopted. The venation of the wings is also quite variable, and any cell that may be accepted as a criterion may be closed or open in any of the subfamilies. The presence of genital spines in the female is a character that may be associated with the method of oviposition of the species having them, but apart from being applicable to but one sex, and therefore not a commendable character to use for generic purposes unless a co-ordinated character is present in the male, adaptive characters due to habits or habitats are not reliable as indices to relationships, so many parallelisms occurring in all groups. It is noteworthy that in the Muscid genus *Hylemyia* Robineau-Desvoidy there are a few species which have similar genital spines and, so far as I know, these species deposit their eggs at the bases of cereal plants, such as wheat. Those species have not been separated generically from the normal species of *Hylemyia* which lack genital spines, some of which species have similar egg-laying habits to those that possess spines. There are also other Muscid genera in which either all or a part of the species have genital spines in the female but nothing is known of their methods of oviposition.

In connection with the subdivision of the old genus *Asilus* Linné, in which the genital spines have been used to some extent as distinguishing characters, it may be well to mention that American authors have disregarded Loew's genera, though some European authors attempt to make use of them. One result of trying to segregate both European and American species of *Asilus*, *sens. lat.*, in accordance with Loew's concepts, is that a number of additional genera, or subgenera, would have to be erected for the reception of species which do not fall readily into any of the genera proposed by Loew. An examination of his work shows that originally he proposed the named segregates of *Asilus* as subgenera, but later, in his paper on African Diptera (1860), he presented a key to the group and gave them full generic rank. As one of the major groupings is based upon the genital structure of the females, and quite a few of the genera are distinguished merely by colour characters, the scheme can hardly commend itself to anyone who desires generic distinctions to consist of structural characters segregating groups and applicable to both sexes, which incidentally in my opinion is the only method to pursue if one intends to attain any degree of permanency for the system, and especially if one hopes that it will be generally adopted.

Subfamily Laphrinae.

Genus Atomosia Macquart.

This genus is listed as occurring in Australia and, judging from the characters given by Miss Ricardo in her key to the genera of Laphrinae, the species placed here by her ought to run very close to the genus if not actually belonging here. I have no species of the genus from Australia, but have one before me which can be placed in neither that genus nor *Aphestia*, though it most closely resembles the former, and in some respects also is very similar to *Laphystia* Loew, or at least the North American species placed therein. I have carefully examined the genotype of *Atomosia* and compared it with the Australian species and this comparison shows that though the two species are superficially similar there are a number of quite important characters in which they differ. The marginal (ambient) vein of wing is discontinued at the apex of fourth branch of media in *Atomosia*, the margin from there to base of wing, including alula, lacking a distinct vein, the alula is quite poorly developed, and the second branch of radius connects with first well before apex of latter, the cell between the costa and first branch being rather wide to tip. In addition to these venational characters the metanotum has on each side a group of hairs mixed with bristles, and there are deep punctures on dorsum of thorax, part of pleura, and dorsum of abdomen.

The Australian species agrees with *Atomosia* and *Laphystia* in having the prosternum all in one piece, uniformly chitinous, and connecting with the dorsal portion of the prothorax, forming thus a continuous collar, as distinguished from the structure of the prosternum in *Deromyia* Phillippi, and most other genera, in which there is a well defined central chitinous plate separated by a membranous, or submembranous, section of variable width on each side from the upper chitinous portions. This complete prosternum is present in all the genera of the subfamily Laphriinae seen by me, and might prove of more significance as a distinguishing character than the single venational character now in use for separating the subfamily from Dasypogoninae. The occurrence of the complete prosternum in a few genera now placed in the latter group may indicate that these are wrongly placed, but further investigation of the matter is desirable

before a definite decision can be expected. The genera referred to are *Lasiopogon* Loew, *Holcocephala* Jaennicke, and *Stichopogon* Loew. The same character occurs in Leptogastrinae.

It may appear strange that except for a very recent reference by Ricardo, the discontinuance of the marginal vein has not been noted in this group, as the continuous marginal or ambient vein is generally accepted as one of the outstanding group characters, but nevertheless it is lacking, as above noted, in *Atomosia* and in *Cerotainia* Schiner, or at least in the North American species placed in the genus, and in *Laphystia* Loew from the same region it is lacking on the alula, and from the anal angle to the apex of anal cell, and present on outer side of the cleft between the anal angle and alula. The alula in the last-mentioned species is quite large and a little pointed at outer lower angle as distinguished from the regularly rounded form in most genera. In the Australian species before me the ambient vein is complete, distinct even on alula, and the second branch of radius connects with costa rather than with first branch of radius, but I expect there may be some variation in this last character as is the case in *Laphystia* which it closely resembles in this respect. I note here that the genus *Triclis* Loew, or at least the American species placed in the genus, has the marginal vein complete and if this holds for the genotype it is distinct from *Laphystia* and not a synonym as stated by some authors. There are no metanotal hairs in *Laphystia* nor in the Australian species.

The latter has the third antennal segment hardly longer than the first two combined, and the abdomen is not distinctly punctate; it can not be referred to *Atomosia* for the reasons stated above, and it can hardly be placed in *Aphestia* Schiner because of the much shorter antennae. Whether it belongs to some described genus or not I am unable to say at this time.

Genus Nusa Walker.

This genus has but recently been elucidated by Ricardo, and *Dasythrix* Loew has been sunk as a synonym of it by that author. It was erroneously recorded as occurring in Australia, the present distribution confining it to Africa and the Orient. In this genus we find a recurrence of the incomplete ambient vein as in the genera discussed under *Atomosia*, but the first and fourth posterior cells of wing are closed, and the apices of the branches of media are evanescent, being hardly traceable to margin of wing. None of the genera above referred to agrees with it in those characters. The species previously recorded as belonging here is now removed to *Andrenosoma* Rondani.

Genus Laphria Meigen.

This genus is based upon a European species which I do not have access to at present, and if published records are dependable it is cosmopolitan. Here again we find a complete prosternum, and in the North American species there are two groups, one with hairs on each side of the metanotum, and the other without hairs. I consider these groups are entitled at most to subgeneric distinction. All the large stout hairy species in North America usually placed in the genus *Dasyllis* Loew have the hairs present, as do most of the species of slender build which have the dorsum of abdomen densely haired, the smaller slender species which have fewer hairs on the dorsum of abdomen lack the hairs, as does also *gilva* Linné.

Genus ANDRENOSOMA Rondani.

This genus differs from the preceding one in having the first posterior cell of wing closed, and the male hypopygium with the forceps extending beyond the basal lateral arms as a rule, the forceps of *Laphria* species usually being more or less hidden between the lateral arms. One species from Mexico (*formidolosa* Walker) and another from British Guiana (*pyrrhopyga* Weidemann) evidently belong here. Both of these species have the metanotum haired on each side. The Australian species *tectamus* Walker is evidently congeneric though in it the metanotum is bare. These two groups are similar to the two in *Laphria* above referred to and may constitute distinct subgenera.

Genus MAIRA Schiner.

Another genus very similar to *Laphria*, but the face is less prominent below, and the metanotum is bare. I have seen the genotype and one or two other species that I consider belong here, one from New Guinea in the United States National Museum being named *aenea* Fabricius by Coquillett.

Subfamily DASYPOGONINAE.

This subfamily is more extensive than Laphrinae and presents a more diverse habitus in its constituent genera. The usual method of separation is by means of the wing venation, the marginal cell being given as closed invariably in Laphrinae, and open, or but rarely closed, in Dasypogoninae. However, as already indicated, there are variations in the venation which preclude it being adopted as an invariable index to subfamily segregations. I do not purpose to go farther in defining the two groups than I have already gone in indicating the complete and incomplete prosterna as possible indices to the divisions, and below offer merely some notes on genera which either occur, or are reputed to occur, in Australia. The data presented are drawn from material in the United States National Museum collection of Australian species, which is not at all comprehensive, and from my own collection.

Genus DEROMYIA Phillippi.

This genus has been recorded from Australia. I have not seen an Australian species of the genus, but have before me the genotype, *gracilis* Phillippi, from Chile, lent me by the United States National Museum.

A number of years ago Williston published the statement that *Diogmites* Loew is synonymous with *Deromyia*, and Osten-Sacken objected to that opinion, asserting that they were at least entitled to subgeneric separation. However, most recent workers have accepted Williston's dictum, and the North American species congeneric with *Diogmites platyptera* Loew have all been considered as belonging to *Deromyia*.

It appears to me, after a careful examination of the genotypes, that *Deromyia* is not congeneric with *Diogmites* for the following reasons: The ocellar region has on it in *Deromyia* a few microscopic hairs only, while in *Diogmites* there are two very strong bristles; the fore tibial spur in *Deromyia* is blunt at apex and is opposed to a short ridge or wedge-shaped elevation on basal portion of the ventral surface of fore metatarsus, while in *Diogmites* the spur is sharp at tip and rests in a depression surrounded in part by a number of short stout spines; the basal two antennal segments in *Deromyia* are subequal in length, while in *Diogmites* the basal one is much shorter than the second, and in the former the

third segment has a few fine hairs above at, or just beyond, middle while in *Diogmites* there are hairs on almost the entire basal half of upper surface. It is also worth noting that the apex of fourth posterior cell is truncate in *Diogmites*, with the vein closing it as long as the cross-vein above it, while in *Deromyia* the cell is pointed at apex, with the vein closing it at least twice as long as the cross-vein above it.

From the above data one may be able to determine if the genus *Deromyia* occurs in Australia.

Genus Saropogon Loew.

I have not any species of this genus from Europe and lack the genotype, so my deductions are based upon an examination of North American species placed in the genus by previous workers.

The American representatives of this genus are rather similar to *Diogmites*, differing essentially in having the fourth posterior cell almost invariably open, and in having from six to ten quite strong ocellar bristles. The part of ventral surface of basal segment of fore tarsus opposed to the tibial spine is usually raised, tuberculate, but not so much so as in *Blepharepium* Rondani. In the latter, which is closely allied to this genus and *Diogmites*, the fourth posterior cell is closed and the ocellar region has only short hairs, while the pulvilli are not more than half as long as the claws, being much shorter than in the other genera.

The species of New Zealand Asilidae placed by Hutton in *Saropogon* that are in my collection now do not agree with the North American forms, having the ocellar region without well developed bristles, and the third antennal segment without hairs above on basal half. These hairs are possessed by all four American genera mentioned in this and the preceding discussion of species.

Genus Chrysopogon Roeder.

This genus is readily distinguished from its relatives by the strong spine situated on a short elevation on each side of mesonotum just above base of wing. I have seen only *albopunctatus* Macquart.

Genus Neosaropogon Ricardo.

I believe no genotype has been designated for this genus, so name *princeps* Macquart, the first included species.

It is possible that with the accession of more material I may be able to present some more notes on this family at some future date. The foregoing may, however, prove of some small value to those interested in a group which presents interesting features both in taxonomy and biology.

The succeeding part of this paper is devoted mainly to descriptions of new species and to completing work already partly done in previous papers of the series. It has been my intention to present synoptic treatments of all groups dealt with as the work progressed as I have no guarantee that I may be able to continue the series and consider that such synopses are essential to others should I cease now.

Family Chloropidae.

Subfamily Botanobiinae.

In part xiii of this series of papers I presented a key to the genera of this subfamily, but did not include a key to the species of the following genus.

Genus PARAHIPPELATES Becker.

Since the publication of my key to the species of *Parahippelates* in the first paper of this series (These PROCEEDINGS, xlviii, 1923, 620) I have described some additional species of the genus in part iii (Id., xlix, 1924, 329-331) and in part vi (Id., l, 1925, 96). It thus appears necessary to publish a new synopsis of the species, which is presented below.

One of the species is made the basis of a new subgenus, and possibly it might be accorded full generic rank, but the segregation of a single species does not appear advisable at this time. Should more species occur in which the mesopleura is hairy, full generic status might be accorded the group, as the presence of mesopleural hairs is quite exceptional in this family.

Key to the Species.

1. Wing with a large well defined black mark either in centre or on costa 2
   Wing without a well defined black mark, at most with a brownish costal suffusion 3
2. Wing with a large black patch in middle, covering about one-third of its area; arista practically nude, not twice as long as third antennal segment; femora largely black; length, 3·5 mm. ..... *ornatipennis* Malloch
   Wing with a large black mark on costa which extends from a little beyond apex of first vein to just beyond apex of second, but not behind third vein on disc; arista with short hairs, its length about three times that of third antennal segment ..... *costomaculata* Malloch
3. Arista white, with dense short white hairs; femora and tibiae largely or entirely fuscous; halteres fuscous brown; wings hyaline, last section of fourth vein more than twice as long as preceding section; thorax dark fulvous, with distinct, but not dense, pale dusting ..... *albiseta* Malloch
   Arista and its hairs dark, not white 4
4. Costa of wing rather noticeably browned from apex of first vein to apex of fourth; dorsum of thorax fulvous yellow, very distinctly shining, with very faint dusting; third antennal segment largely brown; longest hairs on arista about as long as its basal diameter ..... *brunneicosta* Malloch
   Wings without evident costal clouding 5
5. Arista densely short haired, the longest hairs distinctly longer than its basal diameter 6
   Arista almost bare, at most with pubescence which is not as long as its basal diameter 7
6. Pleura and lateral margins of mesonotum rufous yellow, sternopleura black below; mesonotum not shining, and without distinct vittae; outer cross-vein at almost twice its own length from apex of fifth ..... *duplicata* Malloch
   Thorax black, propleura rufous yellow, mesonotum shining, distinctly vittate; outer cross-vein at a little more than its own length from apex of fifth vein ..... *aequalis* Becker
7. Hind tibial spur straight, very small and fine, and not nearly as long as tibial diameter, sometimes even indistinguishable 8
   Hind tibial spur curved, and stout, at least as long as tibial diameter 10
8. Mesopleura with fine pale hairs on entire surface; disc of scutellum with fine dark hairs and some on sides below level of the bristles; upper extremity of outer cross-vein nearer base of wing than lower, i.e. the outer cross-vein sloped towards base of wing from lower to upper extremity ..... (Subgenus *Terraereginia*, nov.) *dasypleura*, n. sp.
   Mesopleura bare; scutellum with a few stiff hairs or setulae on disc; outer cross-vein sloped outward from lower to upper extremity 9
9. Legs testaceous yellow, only the apical two tarsal segments of mid and hind legs slightly darkened; fifth visible tergite and hypopygium of male yellow, the former with several rather fine long black downwardly directed bristles on its sides; thorax with the dorsum evenly and densely coated with grey dust; a line drawn in continuation of outer cross-vein to costa would pass through second vein close to its middle ..... *seticauda*, n. sp.

Legs with at least the hind femora and tibiae largely fuscous; dorsum of thorax glossy purplish-black, with quite faint dust centrally, most distinct on two narrow submedian vittae; a line drawn in continuation of outer cross-vein would strike costa close to, or even slightly beyond, apex of second vein ..... *anomala* Malloch

10. Eye distinctly higher than long, and about three times as high as cheek; small species, about 2·75 mm. in length; all femora broadly infuscated at middle in female ..... *parva*, n. sp.

Eye distinctly longer than high, and not twice as high as cheek; larger species, more than 3·5 mm. in length 11

11. Femora entirely tawny yellow, or very faintly darkened in middle .. *nudiseta* Becker

Femora blackened except at apices and, very narrowly, at bases .. *fuscipes* Malloch

N.B.—I believe that I have two additional species before me, one from Sydney, N.S.W., the other from Blue Mts., but there are only single specimens of each available, so I am leaving them aside pending the receipt of more material.

PARAHIPPELATES SETICAUDA, n. sp.

Male and female.—Head bright lemon-yellow in male, duller yellow in female, frons above, including the upper portion of the triangle, and the occiput except its lower third, fuscous, and grey dusted, antennae and palpi yellow; aristae fuscous, basal two segments yellow; all hairs and bristles generally black in female, only those on frons black in male. Thorax black, slightly shining on dorsum, densely grey dusted, without dorsal vittae; a few pale hairs on mesosternum. Abdomen of male dark brown, with the apices narrowly, and incurved lateral portions of visible tergites 1 to 4 broadly, and all of tergite 5, yellow, in the female the tergites are dark brown, with narrow apical yellow margins. Legs yellow, paler in male, apices of tarsi slightly browned. Wings hyaline. Halteres yellow.

Frons at vertex about one-half the head width, and about as wide as long, not noticeably narrowed in front, triangle extending about three-fourths of the way to anterior margin; eye about 1·25 times as high as long, vertical, and about three times as high as cheek, rather less in female; arista subnude. Thorax with the dorsocentral bristles quite well developed, the acrostichals very weak, and one bristle on anterior margin mesad of each humerus; pleura bare, even the sternopleural bristle normally lacking; basal scutellar bristles half as long as apical pair, the discal hairs weak. Fifth visible tergite of male with quite long downwardly-directed black bristles on margin. Hind tibial spur indistinguishable. Ultimate section of fifth vein subequal to penultimate section of fourth.

Length, 2·25-2·75 mm.

Type, male, Sydney, N.S.W., 25.1.1925; allotype and four paratypes, same locality, 26.11.1924; one female, Warburton, Vict., 13.1.1924 (F. E. Wilson). The Sydney specimens were taken by Dr. E. W. Ferguson.

PARAHIPPELATES PARVA, n. sp.

Female.—Head clay-yellow, frons brownish above, triangle fuscous and grey dusted, upper occiput coloured as triangle; third antennal segment brown above; palpi yellow; inner mouth margin not darkened. Thorax fuscous to black, dorsum slightly shining, evenly and rather densely grey dusted, the vittae very faintly indicated. Abdomen coloured as thorax, more evidently shining, and less dusted. Legs pale testaceous yellow, all femora broadly infuscated in middle; apical two tarsal segments of hind legs very slightly darker than basal three. Wings hyaline. Halteres yellow. Hairs on coxae, sternopleura, and part of fore femora, white, elsewhere dark.

Frons at vertex more than half the head width, and wider than long, narrowed to anterior margin, triangle broad, extending beyond middle of frons; lateral

setulae long; arista with distinct pubescence; eye about 1·25 times as high as long, and about three times as high as cheek. Thorax with the dorsocentrals weak except posterior pair, the acrostichals fine and short, sometimes one or two pairs rather long; scutellum with the basal bristles shorter than apical pair, and the two discal hairs weak. Hind tibial spur black, curved, close to apex, and about as long as the tibial diameter. Ultimate section of fifth vein subequal to penultimate section of fourth, the latter about one-third as long as its ultimate section.

Length, 2·5-2·75 mm.

Type, Sydney, N.S.W., 29.12.1923; paratypes, same locality, 29.1.1925, and 1.2.1925.

The two species of which I am uncertain are closely related to the above, and are about the same length.

PARAHIPPELATES (TERRAEREGINIA) DASYPLEURA, n. subgen. et sp.

This species is placed in a separate subgenus, of which it is the only known species, on the character of the finely haired mesopleura. The dorsocentral bristles are very short and fine except the posterior pair, the acrostichals are represented by microscopic hairs, the scutellum is thicker than in typical *Parahippelates*, has many microscopic hairs on the disc and on sides, and the basal bristles are placed higher than in the other group. The backward inclination of the outer cross-vein of wing is very pronounced. I do not cite any but the haired mesopleura as a subgeneric character.

Female.—Head testaceous, anterior margin of frons more orange-yellow, upper portion of frons, including triangle, brownish-black, shining, distinctly grey dusted, anterior portion of frons, face, and cheeks anteriorly, yellowish-white dusted, posterior portion of cheeks and the occiput densely white dusted, centre of occiput above brownish-black; antennae and palpi orange-yellow, slightly white dusted; arista fuscous. Thorax fuscous, dorsum distinctly shining, slightly brownish-grey dusted and with three rather evident brown vittae; pleura densely greyish-white dusted, and white haired. Abdomen brown, slightly shining, apices of tergites yellowish, and grey dusted. Legs testaceous yellow, coxae greyish, fore pair white dusted, all pale haired; all femora broadly fuscous on middle, grey dusted, and mostly pale haired, fore and hind tibiae slightly browned centrally, all tarsi with all of fourth and fifth segments, and apex of third, fuscous. Wings clear, veins pale, yellow at bases. Halteres pale yellow.

Frons at vertex more than half the head width and almost twice as wide there as at anterior margin, triangle extending well beyond middle of frons, evanescent anteriorly, all bristles rather short and weak; eye about as long as high, diagonally placed; cheek pale haired, one-third of the eye height; vibrissae short and fine, yellow; third antennal segment orbicular; arista swollen at extreme base, from there to apex filiform, practically bare. Thorax with the bristles as in genus, but rather weak. Hind tibial spur short and straight, pale coloured; basal segment of all tarsi more than half as long as tibiae. Penultimate section of fourth vein about one and a half times as long as ultimate section of fifth.

Length, 4 mm.

Type, Macknade, Qld., 1918.

Family Lonchaeidae.

This family is quite generally recognized by systematists now, but a few years ago it was considered as a subfamily of Sapromyzidae. In my opinion there are no structural similarities in the two groups that justify their being placed in one family, as such concepts are entertained today in the Acalyptratae. In fact there are evidences of a closer approach to the Ortalidae than to the Sapromyzidae in certain structures of Lonchaeidae. At this time, however, we are primarily interested in discovering what species occur in Australia and not so much in solving the matter of group affinities.

Until recently *Lonchaea* Fallen was the only genus accepted by systematists, with *Earomyia* Zetterstedt, *Dasiops* Rondani, and *Teremyia* Macquart considered as synonyms. A few years ago Bezzi undertook some work on African and Oriental forms, and in 1920 he erected two new subgenera, *Lamprolonchaea* and *Carpolonchaea.* There is also another named segregate, *Acucula* Townsend, erected as a genus for the reception of *saltans* Townsend, a Peruvian species.

Bezzi attempted to link up certain structural characters of the adults with the food habits of the larvae in distinguishing the subgenera. *Lonchaea* he defined as containing "saprophagous species living in decaying vegetable matter or in excrement, and those apparently parasitic on various parts of vegetables", the adults with "a bare or only microscopically pubescent arista, rather long antennae, which reach at least to the middle of face, and well developed chaetotaxy". *Dasyops* Rondani, he considered, contained "the gallmaking species" in which the adults "have a bare arista, very short antennae, not reaching middle of face, and an inflated head, with less developed chaetotaxy". The third group he considered in his first paper as containing "fruit inhabiting species, which have a more or less plumose arista (with the exception of *aurea*), very long antennae, reaching to or even extending below the mouth border, and a much developed chaetotaxy". He subsequently removed *aurea* from this third group on the basis of the bare arista.

With reference to the larval habits I have this to state: Bezzi cast doubt on the record of Perris of predaceous habits in the larvae of *Lonchaea*, stating that he had no real observations to offer. I have, however, on several occasions reared *L. polita* Say in North America and find that the larvae readily feed upon larvae and puparia of other species, and even their own. This species lives under bark. There are also two species known to me which belong to *Lonchaea* in the strict sense, which have been reared from heads of thistles, and from the nest of a wood-boring bee. Also I consider it highly probable that many species which normally feed in the larval stages in excreta or decaying vegetable matter will be found to infest over-ripe or injured fruits and vegetables. Thus I am of the opinion that a careful investigation of the larval habits under diverse conditions will prove that there is very little specialization, and that there is no invariable relation between the larval feeding habits and the structure of the adults. There is practically no distinction between feeding upon decaying fruits and upon over-ripe or injured fruits, and it is difficult to decide in some cases whether the injury in which the larvae are found was caused primarily by them or by another insect, or some other agency. We find in some families species which feed in the larval stages upon dead insects and upon those which are only injured, and occasionally they occur upon perfectly sound specimens.

A peculiar habit of the larvae of at least some of the species of this family is that of springing or leaping. I have found that this is accomplished by the larva

forming a circle while lying on its side, attaching the mouth hooks to the anal extremity, and on the exertion of muscular force releasing the hold, upon which the violent straightening of the body against the surface propels the larva through the air many times it own length, at times as far as four or five inches. I found also that this springing could be induced by placing the larva upon a dry surface, and that so long as the surface remained dry the specimen exhibited exceptional muscular reactions, either springing or rolling over. My interpretation of this reaction was that the dry surface being unsuitable to the larva, causing a rapid drying out of the tissues, active springing or violent motion was resorted to in order more rapidly to locate a more favourable and damp situation. This impression was strengthened by the actions of the larvae when they were placed upon a damp surface, as they uniformly resumed the normal crawling motions of related forms. I have found that there is a similar reaction produced in larvae of many Cecidomyiidae under the same circumstances, but in the latter there is a structure, known sometimes as the "breast-bone", which is utilized in propulsion.

Below I present a synopsis of the Australian species of *Lonchaea, sens. lat.*, available to me, and records of the occurrence of the species.

Key to the species of Lonchaea.

1. Frons with large irregular pits on practically the entire surface; face with a broad central carina which is slightly sulcate above, and on each side with a distinct antennal fovea; arista bare; bright metallic green species; legs black, basal segment of all tarsi except the tip yellow ..... *rugosifrons* Bezzi
   Frons entirely without large pits, sometimes with minute punctures 2
2. Face with a broad well developed central carina which is distinctly sulcate in centre above, and on each side with a broad antennal fovea; arista bare; antennae not extending to mouth margin, third segment about two and a half times as long as wide; in colour similar to *rugosifrons* ..... *aurea* Macquart
   Face almost flat, at least without well defined antennal fovea; antennae extending to, or below, mouth margin, third segment more than three times as long as wide; colour black, with or without a blue tinge; tarsi black or brownish 3
3. Squamae white or yellow, the fringes pale 4
   Squamae brown or fuscous, the fringes dark 7
4. Arista with short pubescence, the longest hairs not nearly as long as its basal diameter; species with a distinct blue tinge, especially on abdomen .... *choreoides* Bezzi
   Arista with short hairs, the longest about half as long as width of third antennal segment 5
5. Tarsi with at least the basal segment yellowish-brown, and quite evidently paler than tibiae; female ovipositor much broader than usual, distinctly wider than third antennal segment except at apex; scutellum bare, or with at most one or two microscopic hairs in addition to the usual four bristles; fifth tergite of abdomen of male not excised at apex ..... *hilli*, n. sp.
   Tarsi black, not paler than tibiae; female ovipositor slender, not as wide as third antennal segment on an apical section as long as that segment; scutellum with some hairs on sides and at apex, in addition to the four bristles 6
6. Fifth tergite of male abdomen elongate, more than twice as long as fourth, tapered to apex, and with a deep central notch at tip, the lateral apical prominences more densely setulose than usual ..... *excisa* Kertesz
   Fifth abdominal tergite of male abdomen broad, not more than twice as long as fourth and without any central notch at tip; usually in the same sex there is a long yellow hair-like penis projecting straight backward beyond apex of abdomen ..... *filifera* Bezzi
7. Scutellum, when viewed from behind, with quite dense brownish dusting; hind femur with a series of anteroventral bristles, most of those on apical half about as long as diameter of femur; scutellum with many setulose hairs apically .... *citricola* Bezzi
   Scutellum, when seen from behind, without any dusting; hind femur without well developed anteroventral bristles; scutellum with few hairs apically 8

8. One of the bristles in the series along lower margin of cheek at least twice as long as any of the others ..... species 1
None of the bristles in the series along lower margin of cheek conspicuously elongated ..... species 2

LONCHAEA RUGOSIFRONS Bezzi.

This species is readily distinguished from its allies by the coarsely pitted frons. There is a North American species, *vibrissata* Malloch, which has the frons similarly pitted, but it has a strong outstanding genal bristle, and is black in colour.

Described from New South Wales, South Australia, and Victoria. I have it from Como, N.S.W., swept from flowers (H. Petersen).

LONCHAEA AUREA Macquart.

Bezzi records this widely distributed species from Eidsvold, Qld.; I have it from Townsville, Qld.

LONCHAEA CHOREOIDES Bezzi.

Originally described from Sydney, N.S.W.; I have two males from Como, N.S.W., swept from flowers (H. Petersen). These specimens were in the same lot in which I discovered the type specimen of *Pachyneres australis* Malloch.

LONCHAEA HILLI, n. sp.

Male and female.—Glossy black, with a pronounced blue tinge on dorsum of thorax and abdomen, most pronounced in the female. Frons shining black, upper orbits blue-black, glossy; antennae and palpi black. Legs black, tarsi brownish, the basal segment palest, but not conspicuously so. Wings hyaline, veins brown, paler basally. Squamae and their entire fringes yellowish-white. Knobs of halteres black.

Frons of male at vertex about twice as wide as third antennal segment, a little narrowed anteriorly, inner vertical, ocellar, and the pair of orbital bristles rather long, outer vertical pair shorter than inner; surface with rather sparse hairs, those on central front portion longest; lunule haired; frons of female about one-third broader than that of male; antennae extending a little below mouth margin, third segment about three and a half times as long as wide; longest hairs on arista about half as long as wide; cheek not higher than width of third antennal segment, with rather short even marginal hairs. Thorax with two pairs of postsutural dorsocentrals, one pair of prescutellar acrostichals, no hairs adjacent to stigmatal bristle, the pteropleura bare, and the scutellum slightly dusted on disc, but with no fine hairs. Hypopygium of male small, fifth tergite tapered to apex, without an apical notch; ovipositor of female fully as wide as third antennal segment, flat, and rather abruptly pointed and bare at apex. Apices of auxiliary and first veins very close together; first posterior cell slightly widened at apex; inner cross-vein a little proximad of middle of discal cell.

Length, 3 mm.

Type, female, and allotype, Darwin, N.A., taken *in copula* (G. F. Hill).

LONCHAEA EXCISA Kertesz.

I have before me one male of this species from Brisbane, Qld. (Dr. Turner).

The species is readily distinguished by the long, rather slender, tapered, and excised apical abdominal segment in the male sex. It occurs throughout the Malay Archipelago, but has not heretofore been recorded from Australia.

LONCHAEA FILIFERA Bezzi.

I identify as this species a number of specimens which are glossy black in colour, with yellowish squamae and fringes, slightly grey dusted scutellum, and in which the males have a long slender hair-like yellow penis which is usually exserted beyond apex of abdomen, often almost as far as the length of last tergite.

The species was originally described from the Philippine Islands and has not been recorded from elsewhere up to the present time.

I have a number of specimens from Cairns, N. Qld., and one pair from Palm Island, Qld. (F. H. Taylor).

LONCHAEA species 1 and 2.

I believe one or other of these species was listed as *citricola* Bezzi by Bezzi, but neither in my opinion may be identified with the Philippine species. I hope to revert to this matter later.

LONCHAEA CITRICOLA Bezzi.

I have before me two specimens from the Federated Malay States which I think belong to this species, but have none from Australia which correspond with them.

Family **Sepsidae.**

I have recently received a paper by Dr. O. Duda in which he presents a monographic study of this family. This paper bears on the front page the date 1925, and on page 153 the notation "Erschienen Dezember 1925". The actual date of publication is of importance, as my paper dealing with the Australian Sepsidae appeared on the fifteenth of the same month, 1925 (These PROCEEDINGS, p. 311), and the decision as to the priority of *Australosepsis* Malloch and *Saltelliseps* Duda depends upon the day of issue apparently, though the dates of publication appearing upon many continental European magazines since 1914 are notoriously unreliable.

In connection with Duda's paper it may be pertinent to note that the genus *Formicosepsis* de Meijere does not belong to Sepsidae.

Genus LASIONEMOPODA Duda.

In my paper above referred to, I suggested the possibility of segregating *Sepsis hirsuta* de Meijere from the others contained in my concept of *Sepsis*. My suggestion was that the species might be considered as a distinct subgenus, but Duda has gone farther than this and erected the above genus with *hirsuta* as genotype and sole species.

The characters of the genus are as listed in my paper, the haired frons being the outstanding feature mentioned by Duda.

Genus AUSTRALOSEPSIS Malloch.

As already indicated there is some question as to whether this name has priority over *Saltelliseps* Duda.

AUSTRALOSEPSIS FULVESCENS Malloch.

This species is apparently close to, possibly even the same as, *niveipennis* Becker var. *robusta* Duda described briefly in the paper by Duda above referred to. Typical *niveipennis* occurs in Africa and South-Eastern Asia, variety *robusta*

in Formosa. Only a comparison of material from the different regions will determine the status of the species, though a wide distribution is to be expected in species which are scavengers in the larval stages as this undoubtedly is.

Genus Podanema nov.

This genus belongs to Duda's group Nemopodinae which latter, despite the evident intent of Duda as indicated by the name, is not entitled to consideration as a subfamily.

The new genus is distinguished from related forms in Duda's paper by the projecting lower margin of face, a quite exceptional character in Sepsidae, the presence of one pair of orbital bristles, the short stout ocellars, postverticals, and inner verticals. The outer verticals listed as "Po" by Duda are lacking. In most characters the genus resembles *Nemopoda* Robineau-Desvoidy, but the outer verticals are present in the latter. From *Pseudonemopoda* Duda it differs in having quite a strong pair of orbital bristles, and in some other characters.

Genotype, the following species.

Podanema atrata, n. sp.

Female.—Black, slightly shining. Frons slightly brownish in front, face and antennae brownish-yellow, with greyish dust. Thorax entirely and quite densely dusted, brown on mesonotum except the sides, the latter and pleura pale grey dusted. Abdomen more evidently shining than thorax, with grey dusting, the apex of first complete tergite with a broad fascia of silvery white dust, most conspicuous when seen from behind. Legs black, trochanters rufous. Wings hyaline, narrowly black along costa to apex of auxiliary vein. Halteres black.

Frons at posterior ocelli about one-half the head width, and about as wide as long, slightly narrowed to anterior margin, surface with some faint longitudinal striae, orbits with dense white pile along anterior portions; postvertical bristles longer than any of the others, the verticals, ocellars, and orbitals, about equal in length; face slightly produced from upper to lower margin, with a depression on each side in which the antennae lie; vibrissal angle with two bristles and some much shorter hairs; third antennal segment about four times as long as second, tapered to apex; arista not much longer than antenna, bare; palpi very small but evident, with one or two apical hairs. Thorax with the following bristles: one humeral, two noto-pleurals, one supra-alar, one post-alar, one pair of dorsocentrals, one mesopleural, and two scutellars; the dorsal hairs almost indistinguishable. Tergites without outstanding bristles. Legs slender, fore coxae with a few apical bristles; prosternum with fine hairs; fore femur with a rather closely placed series of short spines on apical half of anteroventral and posteroventral surfaces, and no processes; fore tibia slightly thickened apically; fore tarsus broadened from before apex of basal segment to tip of fifth; mid femur with a depression near middle above; mid tibia with one or two posterodorsal and about seven posterior bristles, all short; hind femur with a number of bristles along anterodorsal surface; hind tibia with three or four very short anterodorsal bristles. Fourth vein bent down basally so that the basal cell is wider than discal for some distance at base of latter; first posterior cell not twice as wide at apex as at base, owing to the forward slope of apical section of fourth vein; sixth vein not extending to margin of wing.

Length, 5-6 mm.

Type and two paratypes, Townsville, Qld. (F. H. Taylor).

The genus is distinguished from *Sepsis* by the presence of but one pair of dorsocentral bristles, and a mesopleural bristle. To this genus also belongs *viduata* Thomson, but it has no dark basal streak on costa, and the bristles are shorter on thorax and head, the humeral almost indistinguishable, and ocellars minute.

Family Piophilidae.

I have previously recorded the genus *Piophila* Fallen, with two species, as occurring in Australia. Below I am adding a new genus of the family.

Genus Chaetopiophila nov.

This genus has the same wing venation as *Piophila*, the costa and first vein being fused from just beyond apex of the auxiliary vein and presenting the appearance of a thickened costal vein which gradually tapers apically, the inner cross-vein is unusually short, and the sixth vein is obsolete at apex. The frons has a pair of quite prominent setulose hairs, or fine bristles, near anterior margin which are about equally distant from each other and eyes, and there are two orbitals on each side, the anterior one very short. Thorax with 1 + 3 pairs of fine dorsocentrals, one pair of long prescutellar acrostichals, two bristles on each humerus, one incurved, the other backwardly curved, and the presutural bristle large; mesopleura haired, without bristles; sternopleura with one bristle. Ovipositor chitinous, lancet-like.

Genotype, the following species.

Chaetopiophila hyalipennis, n. sp.

Female.—Fulvous testaceous, shining. A large mark over ocellar region and a subtriangular mark at each upper angle of frons which extends down on occiput, black; third antennal segment and aristae, and palpi, except their bases, black. Dorsum of thorax in type specimen with broad fuscous suffusion, indistinctly vittate, possibly in some specimens distinctly vittate. Abdomen brown, paler at base. Legs fulvous testaceous, the femora darkened. Wings hyaline. Halteres yellow.

Frons at vertex fully one-half the head width, narrowed in front, all vertical bristles and the ocellar pair long, the postverticals distinctly divergent, ocellars a little behind level of anterior ocellus; antennae short and broad; frons slightly projecting in profile; face slightly receding below; cheek at posterior margin about as high as eye, the latter a little longer than high; vibrissae long. Thorax with long dorsal hairs which are almost as long as anterior dorsocentrals; disc of scutellum haired, basal bristles about half as long as the long apical pair. Legs normal, no preapical bristle evident on tibiae. Wings rather narrow, inner cross-vein close to middle of discal cell.

Length 2 mm.

Type, Sydney, N.S.W., 14.4.1925.

The genus *Mycetaulus* Loew is not known to occur in Australia. It has only two pairs of dorsocentral bristles, and lacks the pair of long setulae on anterior margin of frons. The genotype has also but one humeral bristle, which is backwardly directed, and the acrostichals and discal scutellar hairs are lacking.

LEPIDODENDROID REMAINS FROM YALWAL, N.S.W.

By A. B. Walkom, D.Sc.

(Plate xxiv.)

[Read 27th June, 1928.]

Some very interesting Lepidodendroid stems were obtained many years ago from the neighbourhood of Yalwal, N.S.W., and I have to thank Mr. W. S. Dun, Palaeontologist to the Geological Survey of N.S.W., for the opportunity of describing them. The material was examined at Cambridge during the tenure of a Fellowship in Science granted by the International Education Board. Yalwal is about 90 miles south of Sydney and 18 miles from the coast, and on account of the occurrence of gold in the neighbourhood, the district has from time to time been examined geologically (Andrews, 1901).

The Rev. W. B. Clarke in his reports on Southern Gold-fields (see Andrews, 1901) divided the sedimentary rocks into two series: the lower, composed of quartzites, slates, etc., including the gold-bearing rocks, he placed as Silurian, and the upper, in which he recorded the occurrence of *Lepidodendron* and *Sigillaria*, he referred to the Carboniferous. The *Sigillaria*, however, has not been discovered since and the probability is suggested below that Clarke's record was based on a specimen (possibly it was the one herein described) which I have referred to *Protolepidodendron*.

The Lepidodendra obtained from the series which Mr. Clarke placed in the Carboniferous, were briefly described by W. S. Dun (in Andrews, 1901, p. 16) as follows: "A most interesting small-patterned *Lepidodendron*. The leaf bases vary in size from 3 mm. × 2·25 mm. to 4 mm. × 3 mm. Several specimens, however, show a more elongate form—7 mm. × 4 mm. The leaf cushion is well raised, about one-third along axis from the apex of the leaf base. The print of the vascular bundle is well marked. No traces of parichnos or ligule are preserved. There appears to be no doubt that this species is new. The smaller leaf bases have much the appearance of some forms described as *Ulodendron* (without the large rounded scars). There is an apparent resemblance to forms of *L. Sternbergi* and *L. Heeri* Nathorst from Spitzbergen".

The smaller-patterned form first mentioned by Dun would be the species described below as (?) *Lepidodendron Clarkei*, n. sp., and the larger form with leaf bases 7 mm. × 4 mm. is probably what is here described as *Protolepidodendron yalwalense*.

The rocks in which these fossils occur were assigned by Andrews (1901, p. 16) to the Devonian on account of their lithological characters and their mode of occurrence. Of course, Clarke's determination of some of them as Carboniferous was sound if his record of *Sigillaria* and *Lepidodendron* had been correct.

The occurrence of species of *Protolepidodendron* supports the determination of the age of the rocks as Devonian. *Protolepidodendron primaevum*, to which the two Yalwal species show close resemblance, occurs in the Upper Devonian

of New York, and *Lepidodendron karakubense*, another very closely allied species, which may perhaps belong to *Protolepidodendron*, comes from the Upper Devonian of the Donetz Basin.

The Yalwal species form an interesting addition to our knowledge of Devonian floras in New South Wales, and it would be of considerable interest to know the time relation of the rocks in which they were found, to those in which *L. australe* occurs.

The few specimens here described indicate an Upper Devonian age for the rocks at Yalwal in which they occur.

PROTOLEPIDODENDRON LINEARE, n. sp. Plate xxiv, figs. 1, 2.

The specimen here described (Geol. Survey of N.S.W., No. 12474) is part of the collection made at Yalwal and referred to in the report on the Yalwal Goldfield by E. C. Andrews (1901, p. 16). It bears such a close resemblance to some figures of *Protolepidodendron primaevum* (White, 1907) that little hesitation is felt in referring it to that genus. The specimen consists of portion of the impression of a stem, some 9 cm. wide, in which the leaf cushions are arranged in distinct vertical series separated from one another by straight vertical grooves. The leaf cushions are narrow and elongated vertically, about 5 mm. long by 1·5 mm. wide, and the vertical grooves separating them are about 2 mm. apart; the cushions are not separated from one another vertically by groove or ridge, but merge gradually into the adjacent ones above and below.

In addition to the pronounced vertical series of leaf cushions there is also a definite spiral arrangement, the lines of the spiral making an angle of about 55° with the horizontal.

The leaf cushions are noticeably raised and are somewhat fusiform in shape, the greatest width being rather near the top; many of them show a median vertical ridge terminating upwards in a circular or oval area which is probably the leaf scar. It seems not unlikely that the narrow vertical ridge may represent the position of the vascular strand, made noticeable by removal of some of the surface tissue. No trace of the parichnos is to be seen, but in the centre of the leaf scar there is occasionally a small single scar which probably represents the leaf trace.

The most distinctive features of this fossil are the arrangement of the leaf cushions on series of vertical ridges separated by straight grooves and the absence of any distinct horizontal line of demarcation between adjacent cushions. In both respects it shows remarkably close similarity to some of White's figures of *P. primaevum* from the Upper Devonian of New York (White, 1907, especially Plates 9 and 10). The regular vertical arrangement of the leaf cushions is a character in which it resembles some types of *Sigillaria*, whilst the elongate-rhomboid or fusiform shape of the leaf cushion shows greater resemblance to *Lepidodendron*. In *Protolepidodendron primaevum* the cushions are somewhat larger than in my specimen (being both longer and wider but having similar general proportions), but in view of the wide geographical separation and the uncertainty of the exact horizon of the New South Wales specimen, as well as the much more complete available knowledge of *P. primaevum*, it is not felt that the Yalwal specimen should be referred to that species.

Our specimen is quite distinct from *Archaeosigillaria Vanuxemi* (Göppert) which Kidston (1899-1900, p. 38) transferred from *Lycopodites* to a new genus,

Archaeosigillaria, which, as White (1907, 339) pointed out, is probably synonymous with *Protolepidodendron*.

In *A. Vanuxemi* the leaf scars are "contiguous, broadly fusiform on younger branches, hexagonal on older stems, having a single vascular cicatrice" (Kidston, 1899-1900, p. 38). The American specimens come from the Upper Devonian (Chemung Group) of New York, and British examples from the lower beds of the Mountain Limestone of Westmorland, probably of the same age as part of the Calciferous Sandstone of Scotland. Kidston's figures (1885) of *A. Vanuxemi* show the Lepidodendroid type of cushion only on young branches, while on branches which are older, but whose diameter is still comparatively small, the cushions are hexagonal as in *Sigillaria*. It is not known whether older portions of the stem from Yalwal would bear hexagonal leaf cushions, but in view of the similarity of arrangement of the cushions in general to that in *Sigillaria* it seems more likely that the stem here described, which would have a diameter of more than 8 cm., represents the older Sigillarioid portion and that the younger portions of the same stem would bear cushions more resembling *Lepidodendron*.

The Rev. W. B. Clarke recorded the presence of *Lepidodendron* and *Sigillaria* in the beds from which the specimen came, and Andrews (1901, p. 16) states that "the *Sigillaria* mentioned by the Rev. W. B. Clarke has not been discovered since"; it seems more than probable that Clarke's record of *Sigillaria* was based on a specimen similar to that described above.

PROTOLEPIDODENDRON YALWALENSE, n. sp. Plate xxiv, fig. 4.

Two specimens (Geol. Survey of N.S.W., Nos. 12475-6) from Yalwal represent a species quite distinct in appearance and in the character of the leaf cushions from *Protolepidodendron lineare* described above, but the two species may ultimately prove to represent different parts of the stem of a single species.

The leaf cushions are Lepidodendroid in general appearance, vertically elongate-rhomboidal, but are in distinct vertical series as well as spiral in arrangement. The grooves separating the vertical series are, however, sinuous and not straight as in *P. lineare*, so that the cushions in the vertical rows do not appear to occupy distinct vertical ridges as they do in that species. The cushions resemble those of *P. lineare* and other species of *Protolepidodendron* in not being separated from the next above and below, each one merging gradually into the adjacent vertical cushions without the interposition of any horizontal ridge or groove. This is a feature by which *Protolepidodendron* may be distinguished from *Lepidodendron*.

The leaf cushions, which are about 7 mm. long and 4·5 mm. wide, have a well-marked raised area, rather nearer the apex of the cushion than the base, forming a transversely rhomboidal or rounded area representing the leaf-scar. There is in places some slight indication of the presence of the leaf trace in this area, but no trace of the parichnos. In the lower part of the leaf cushion there are occasionally a few transverse wrinkles.

In general appearance this species agrees almost exactly with the higher parts of the stem of *P. primaevum* (White, 1907, Plate 11) in which, however, the leaf cushions are longer but narrower than in our species. The same reasons might be given for not identifying our specimens with White's species as were given in the case of *P. lineare*, described above. It may be that *P. yalwalense* and *P. lineare* represent different parts of the stem of a single species, since *P. primaevum* shows the two types of structure at different levels of the one stem,

but it may be pointed out that the type of leaf cushion exhibited by *P. yalwalense* occurs in *P. primaevum* at a higher level of the stem than does the type shown in *P. lineare*. One would expect the leaf cushions in the higher parts of the stem to be smaller than those lower down; the cushions in *P. yalwalense* are considerably larger than in *P. lineare*, which, added to the fact that the specimen of the latter species is not a very small stem (judging by the curvature it would be at least 8 cm. in diameter), gives some justification for specific separation of the specimens from Yalwal.

A plant very like *P. yalwalense* is *Lepidodendron karakubense* Schmalhausen (1894, p. 33, t. 2, f. 13, 14) from the Upper Devonian rocks of the Donetz Basin, which has similar leaf-cushions in vertical series separated by sinuous grooves and which also exhibits the absence of distinct demarcation between the cushions in a single vertical series. *L. karakubense* has been redescribed and refigured by M. D. and G. Zalessky (1921) who had more complete material and were able to describe petrified stems. This species and *P. yalwalense* show some resemblance in general appearance to *L. Veltheimianum*, but there is a clear distinction in the definite vertical arrangement of the leaf-cushions in *P. yalwalense* and *L. karakubense*, as well as the absence of horizontal separation of adjacent cushions in the same vertical row.

The specimen of *Protolepidodendron Karlsteini* described by Lang (1926, 790) from the Middle Old Red Sandstone of Scotland is a much smaller stem than that from Yalwal, but the shape of the leaf-cushions is similar. In the Scottish specimen, however, the cushions in a vertical series are not so close together, being connected by comparatively long narrow areas sometimes as much as half the length of the cushions themselves. This makes the two species quite distinct in surface appearance.

(?) Lepidodendron Clarkei, n. sp. Plate xxiv, fig. 3.

A specimen from Yalwal (Geol. Survey of N.S.W., No. 12477) consists of a cast of a stem impression, 5 cm. wide, in which the leaf-cushions are very regular in size, rhombic in shape, averaging about 3·5 mm. transverse diameter and 3 mm. vertically, and sharply marked off from one another by well-defined wide diagonal grooves which show as ridges in the cast. The leaf scar is small, situated on a prominently and rather sharply raised projection close to the upper angle of the cushion (from one-sixth to one-third of the length of the diagonal from the apex).

This specimen has the general appearance of *L. australe* except that the leaf-cushions are very much smaller than in that species even though the stem is by no means a small one. Stems of *L. australe* which have leaf-cushions at all approximating the small size of those in this specimen are all comparatively thin; I have before me a branching stem of *L. australe* which is considerably thinner than the specimen here described and which has leaf-cushions averaging about 5 mm. by 5 mm., as well as a second example of the same species, 6 cm. wide (about the same width as the Yalwal specimen), in which the cushions average 8 mm. × 9 mm. Both the examples mentioned are normal specimens of *L. australe*. In addition to this marked difference in the size of the leaf-cushions, it is apparent that the leaf-scar in the specimen from Yalwal was situated on a prominently raised area of the cushion, whereas there is no evidence to show that this was the case in *L. australe*.

The specimen described shows some resemblance to a number of other species, and, in the absence of details of structure, it is referred to the genus *Lepidodendron* only provisionally. Specimens from the Lower Coal Measures of Missouri described and figured by White (1899, p. 218, Pl. 65-68) as *Omphalophloios cyclostigma* (Lesquereux) are very similar in general appearance to (?) *Lepidodendron Clarkei*, but the Missouri specimens are larger, and the absence of details of the structure in my specimen makes it impossible at present to say whether the two are identical. Another similar species is *Omphalophloios anglicus* Kidston (see Seward, 1910, p. 197, fig. 193*c*) from the Upper Coal Measures of Somerset, but this shows distinct vertical grooves and a vertical arrangement of the leaf-cushions which are not evident in the Yalwal specimen. There is also some resemblance in general appearance to some varieties of *Sigillaria Brardi*, a species occurring in rocks of Upper Carboniferous and Permian age (*cf.* Seward, 1910, fig. 203, p. 225). Further there is the genus recently described by Hörich (1915, p. 426) as *Phialophloios*, of which the species *P. quadratus* has similarly shaped leaf-cushions with the scar at the lower angle of the cushion; the specimen from Yalwal shows a considerable degree of resemblance to *Phialophloios quadratus*, as also do many specimens of *Lepidodendron australe*, and all three may possibly be identical, but the Australian species occur in rocks of Devonian age whereas the European *Phialophloios* comes from the Carboniferous.

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EXPLANATION OF PLATE XXIV.

Fig. 1. *Protolepidodendron lineare*, n. sp. Nat. size.

Fig. 2. *Protolepidodendron lineare*, n. sp. (× 2). Portion of Fig. 1 enlarged to show some detail of leaf cushions.

Fig. 3. (?) *Lepidodendron Clarkei*, n. sp. (× $^3/_2$ approx.).

Fig. 4. *Protolepidodendron yalwalense*, n. sp. Nat. size.

ON THE LIFE-HISTORY OF *CERATODUS*.

By Thos. L. Bancroft, M.B., Ch.M. (Edin.).
(*Communicated by I. M. Mackerras.*)

[Read 27th June, 1928.]

From the earliest times (1870) when *Ceratodus* (*Epiceratodus forsteri* Krefft) became known to the scientific world and was described by Gerhard Krefft of the Australian Museum, no one, not even the aborigines, was able to find the very young fish; individuals even six pounds in weight were scarce and only very rarely indeed were specimens two or three pounds in weight taken. The usual weight of fish caught in nets and by line was from sixteen to thirty pounds; larger fish are so powerful in the water that nets do not hold them and, when hooked, they cannot be landed, as the fleshy lips tear away. Few people have seen larger specimens than thirty pounds, yet it has been often stated that the fish grows up to eighty pounds in weight and five feet in length. Fish six pounds in weight are not sexually mature.

The conditions for the favourable propagation of *Ceratodus* no longer occur.

Fertile spawn is produced in large quantities every season, during August and September; it is the annual festival for fish, particularly large jew-fish (*Tandanus tandanus*) and for wood ducks (*Chenonetta jubata*); these animals eat up every particle of spawn they can find, and any that does escape them is devoured by prawns, insect larvae and little fish.

Ceratodus is the living representative of that ancient group of fishes which swarmed the palaeozoic seas, but just why it survived in the Burnett and Mary Rivers is hard to conjecture. It is possible that a few individuals remain in other rivers in Queensland, but owing to their rarity have not been noticed. The late Thomas Illidge wrote a good article on *Ceratodus*, published in the *Brisbane Courier*, August 6th, 1902, in which he stated that he had, whilst living at Gayndah, on the Burnett River, for ten years tried by every possible means to find small forms of *Ceratodus*, but without success; the smallest he did find was fifteen inches in length. My experience, lasting over seventeen years, has been similar to that of Illidge and gives the impression that there are now no young fish growing up or only an odd one or two; in other words *Ceratodus* is nearing extinction.

In the inland seas which existed in Queensland the conditions for *Ceratodus* were favourable; possibly they were shallow seas with abundance of water plants, but without the enemies which now occur in the freshwater rivers. When the seas dried up, *Ceratodus* had to adapt itself to new and less suitable conditions. Another theory that might be advanced is that in ancient times *Ceratodus* had good eyesight, which it has gradually lost, for at the present

day it is practically blind. That the fish is now almost blind can be demonstrated on old specimens as well as on the larval forms, for one may move a straw about closer even than one inch from the eyes without disturbing it. The hearing too is less acute than in other fishes.

Professor Semon, in 1892, with the assistance of Mrs. McCord, of Coonambula Station on the Burnett, reared *Ceratodus* larvae up to ten weeks, and afterwards the late Thos. Illidge likewise reared them to ten weeks and, during the last year he resided at Gayndah, succeeded in carrying a few past their critical period and up to eight months, which specimens he then preserved.

In 1910, the year I arrived on the Burnett, I reared a few up to ten weeks, when they sickened and died; subsequently every year I reared a number, sometimes as many as five hundred, but only two, out of the many thousand hatched during seventeen years, lived through the critical three months stage. If they can be kept alive over three months, they thrive well afterwards.

How to tide the young fish over this critical stage was the problem which had to be solved, and which until recently seemed insoluble.

It was generally considered that the fish was constitutionally weak from in-breeding. Many scientists, to whom I appealed for suggestions as to how to carry the fish over its critical period, were unanimous in considering that it was entirely a question of the proper food. That idea has been probed thoroughly. The larval *Ceratodus* just hatched, which occurs four or five weeks after oviposition, still has some yolk left, but this is used up during the first week; the little fish thrives well for a time, feeding on minute algae. *Tandanus* larvae have been reared in conjunction with *Ceratodus* and were alive and growing well after all the *Ceratodus* were dead, which proved that the food supply was not at fault.

At one time it was considered that the non-success in rearing *Ceratodus* larvae past their critical period was the want of a sufficiently large body of water. Professor Edgeworth, of the University of Bristol, was anxious to secure larval *Ceratodus* for study of the laryngeal muscles; the University sent me a glass aquarium 34 in. × 17 in. × 17 in., but year after year any larval *Ceratodus* introduced into it succumbed within a week.

Although this aquarium has not been of use in rearing *Ceratodus* larvae, yet it has served a useful purpose in that it put me on the track to solve the mystery.

I used it as an ordinary aquarium set up with water weeds and different little fish from the river; algae grew on the glass; frog spawn and young tadpoles were introduced in the hope that they would keep the glass clean, but to my astonishment they only lived a week; it was soon found out that the water was too deep for them. As this was so for frogs, might it not be the same for *Ceratodus* larvae? Eventually half an inch of water was found to be the best depth for the young *Ceratodus*, but quite recently a further discovery was made in that the larvae were observed to rest with their heads out of water and at times with the whole body out of water; when disturbed they will go right out of water and rest there for a while before wriggling back again.

The cardinal points in rearing larval *Ceratodus* are: firstly, to keep them in a very confined space supplied with abundance of food; they seem to be blind and when the food is scattered about they do not find sufficient; and secondly, to keep the depth of water as near half an inch as possible, and to have a diminutive sand-bank on which the fish can rest out of water.

Technique of rearing larval Ceratodus.

Early in August search for suitable spawning grounds on the river in deep lagoons known to harbour *Ceratodus*. Look in the shallowest parts of the lagoon close to the water's edge for water weeds, particularly *Vallisneria* and *Hydrilla*, although, if there are none of these plants, the fish will then spawn in *Nitella* beds, of which there will almost certainly be some; *Nitella* is the first plant to appear after a flood.

It is usually the middle of August when the first spawning occurs.

The eggs are scooped out with a strong landing net with mosquito-net bag; scrape hard on the bottom through the weeds. Put the eggs immediately into a pickle-bottle full of water, the bottle being inserted into a large jam tin or billy-can and kept from direct sunlight.

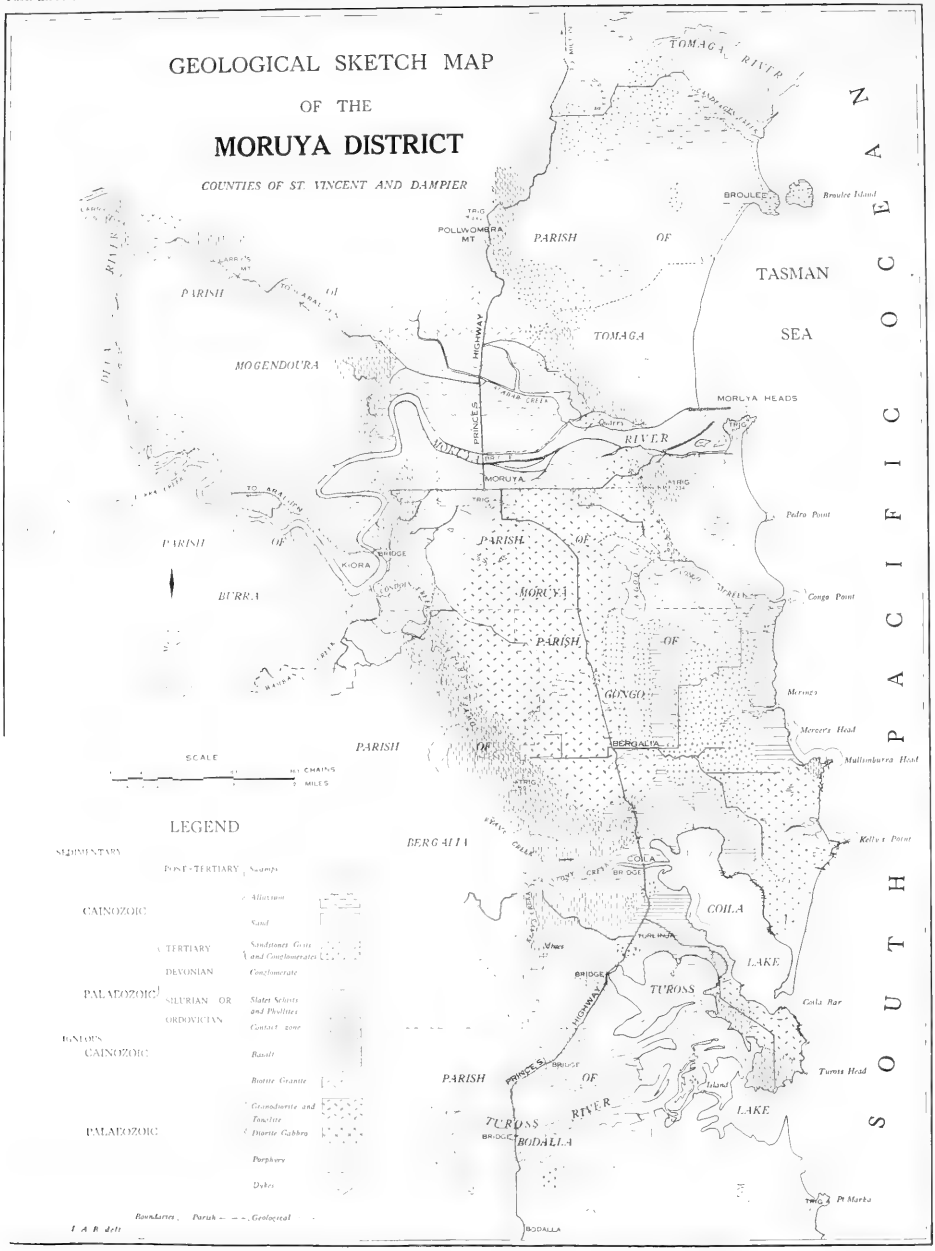
On reaching home transfer each egg to a bottle of water to itself—four ounce medicine bottles are suitable; if the eggs are kept together and one dies, they all die. The bottle should be kept in a dark place and need not be examined again for four or five weeks. When hatching occurs, the water and fish are poured out into a glass cell or other aquarium and a quantity of alga (fine *Spirogyra* if possible) added, the cell being shaded from too much light.

The larvae do quite well for a few weeks in glass jars with about two inches of water, after which they must be transferred to shallow dishes; 12 in. × 9 in. enamel pie-dishes answer well. The water must not exceed half an inch in depth; at one end of the dish place a couple of handfuls of sand to make a sloping bank. Add abundance of algae of different kinds, also mosquito larvae, and arrange a small slate to shade one end. Float the pie-dish in a larger dish and put the whole in a shaded place. It is advisable to cover the whole with mosquito-net to exclude frogs.

Every second day drop in a small piece of hard-boiled yolk of egg, a piece the size of a grain of wheat well rubbed up with a pinch of pollard; I think the fish eat this mixture, but at any rate it serves as food for the mosquito larvae and does not pollute the water. As evaporation occurs a little water must be carefully added, also more algae and mosquito larvae.

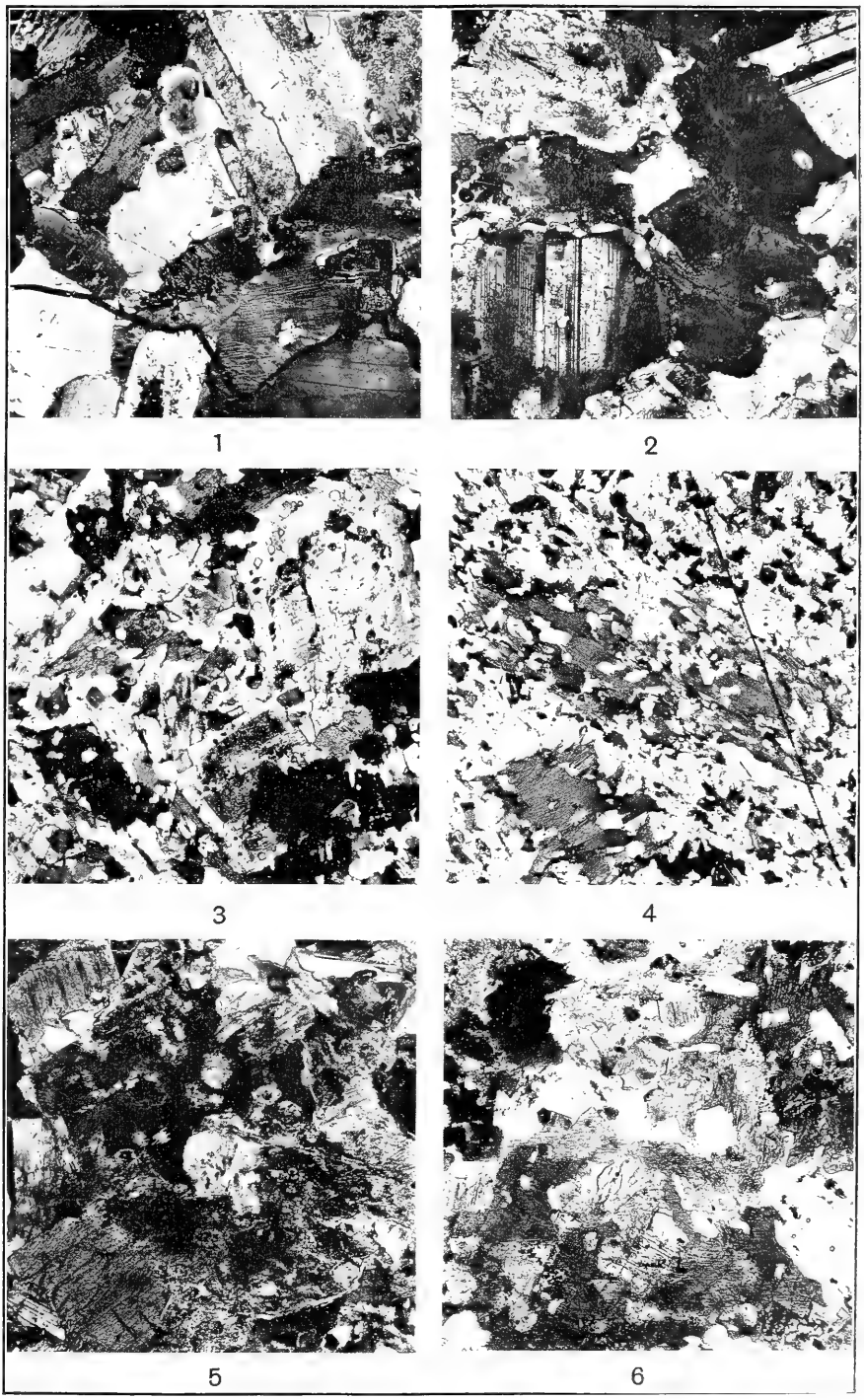
The fish do well in the pie-dishes until they are four months old, when they can be transferred to large aquaria with deeper water, but it is advisable so to arrange the bottom as to give varying depths from half an inch to six inches; the aquaria should be shaded in places with slates and should have abundance of *Vallisneria*.

I once reared a *Ceratodus* until it was two years old in a half ship's iron tank, when a hail storm occurred, filling the aquarium with ice; the fish appeared to be dying, so was preserved. To avoid any such occurrence the aquaria should be under cover.

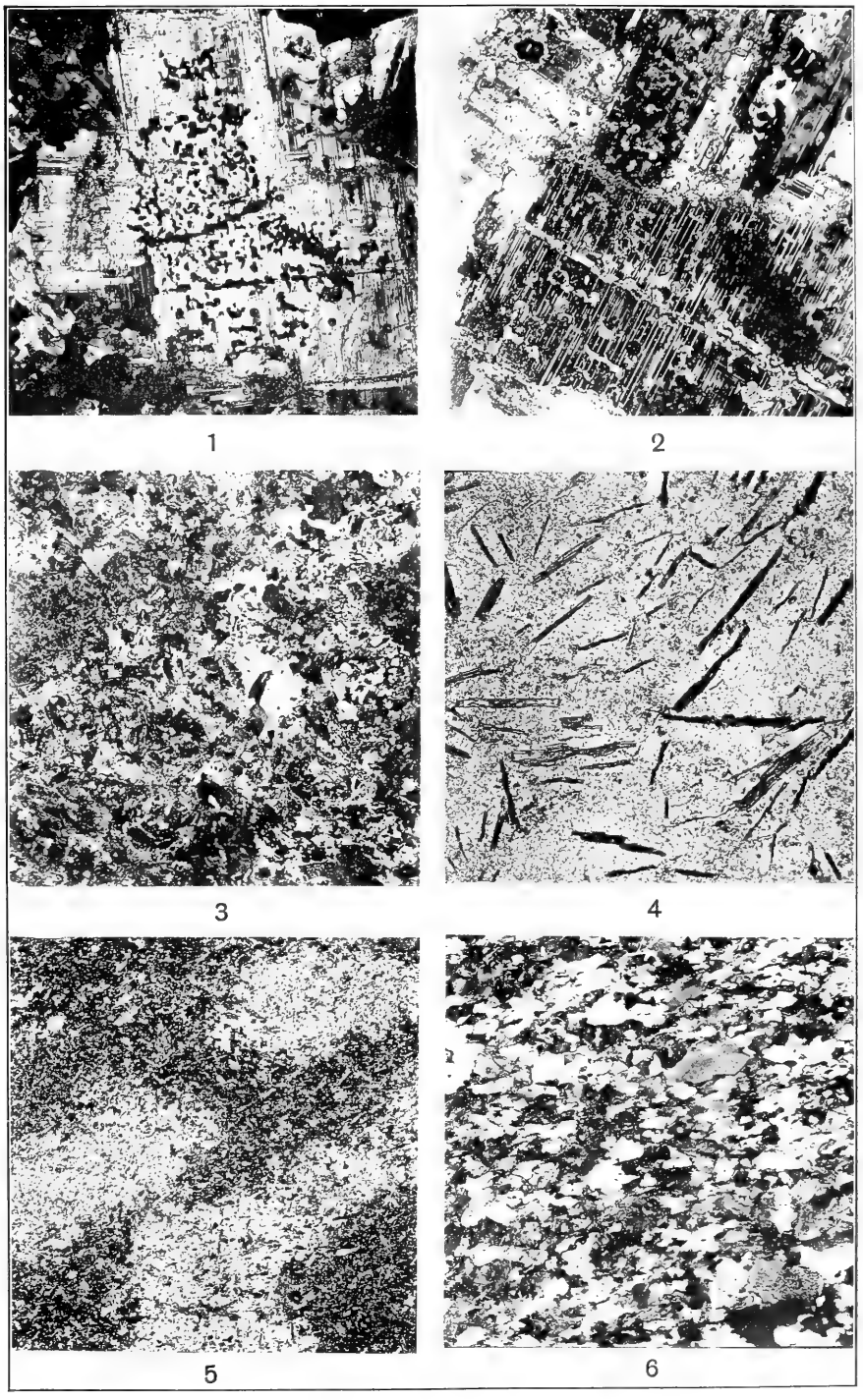

GEOLOGICAL SKETCH MAP
OF THE
MORUYA DISTRICT
COUNTIES OF ST. VINCENT AND DAMPIER
TOMAGA RIVER
BROULEE
Broulee Island
POLLWOMBRA MT
PARISH OF TOMAGA
TASMAN SEA
SOUTH PACIFIC OCEAN
PARISH OF MOGENDOURA
PRINCES HIGHWAY
MORUYA HEADS
MORUYA RIVER
MORUYA
Pedro Point
PARISH OF BURRA
KIORA
BRIDGE
PARISH OF MORUYA
Congo Point
PARISH OF GONGO
Meringo
Mercer's Head
PARISH OF BERGALIA
Mullimburra Head
SCALE
CHAINS
MILES
LEGEND
SEDIMENTARY
POST-TERTIARY
Swamps
Alluvium
CAINOZOIC
Sand
TERTIARY
Sandstones Grits and Conglomerates
DEVONIAN
Conglomerate
PALAEOZOIC
SILURIAN OR ORDOVICIAN
Slates Schists and Phyllites
Contact zone
IGNEOUS
CAINOZOIC
Basalt
Biotite Granite
Granodiorite and Tonalite
PALAEOZOIC
Diorite Gabbro
Porphyry
Dykes
Boundaries
Parish
Geological
BERGALIA
Kelly's Point
COILA
BRIDGE
COILA LAKE
TURLINGA
TUROSS
Coila Bar
PARISH OF TUROSS RIVER
Tuross Head
Island
LAKE
BODALLA
Pt Marks
BODALLA

1. Folded quartzites, near Moruya.

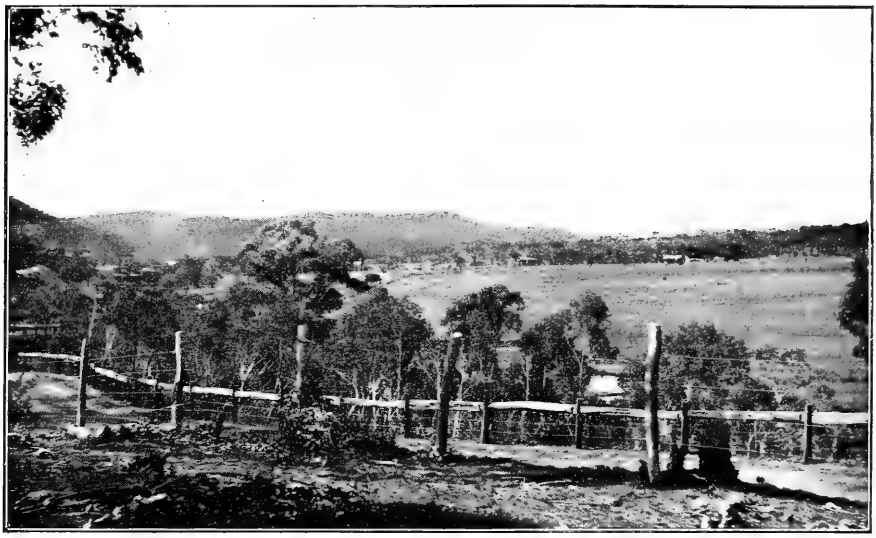
2. Jointing of tonalite and diorite-gabbro, and basaltic dykes at Kelly's Point.



Rocks of the Moruya District.
1. Biotite-granite. 2, 3. Granodiorite. 4. Basic inclusion in Granodiorite.
5, 6. Gabbro.

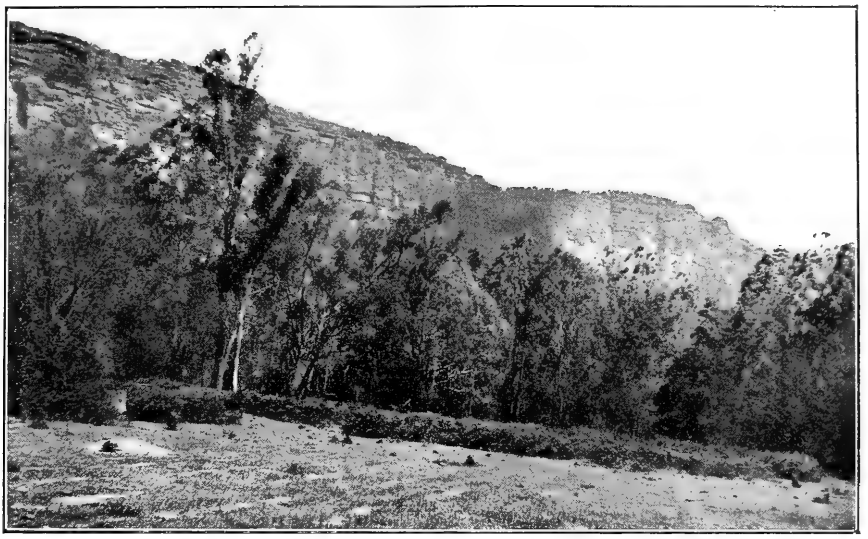


Rocks of the Moruya District.
1, 2. Graphic intergrowth of minerals in Diorite-gabbro. 3. Hornblende-quartz-porphyrite.
4. Mica-lamprophyre. 5. Cordierite-hornfels. 6. Quartz-mica-schist.

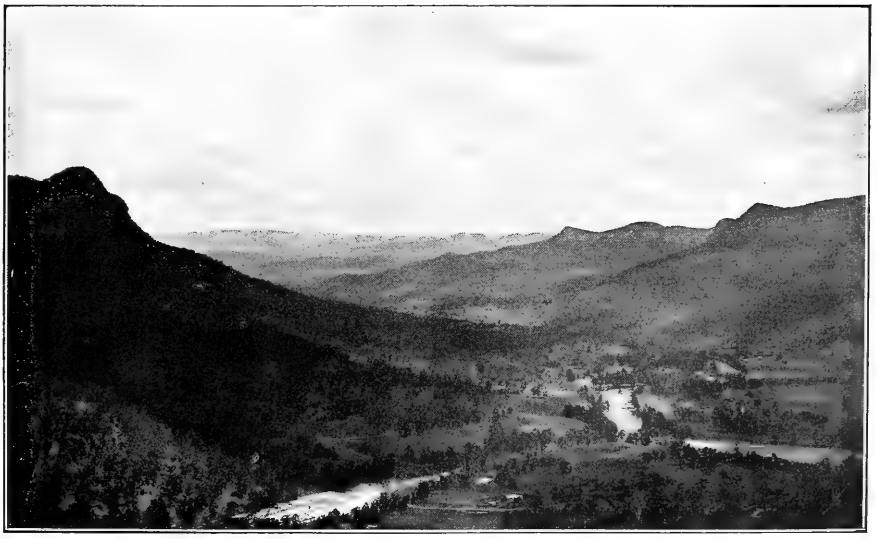


1. Piper's Flat. View from the Main Divide.

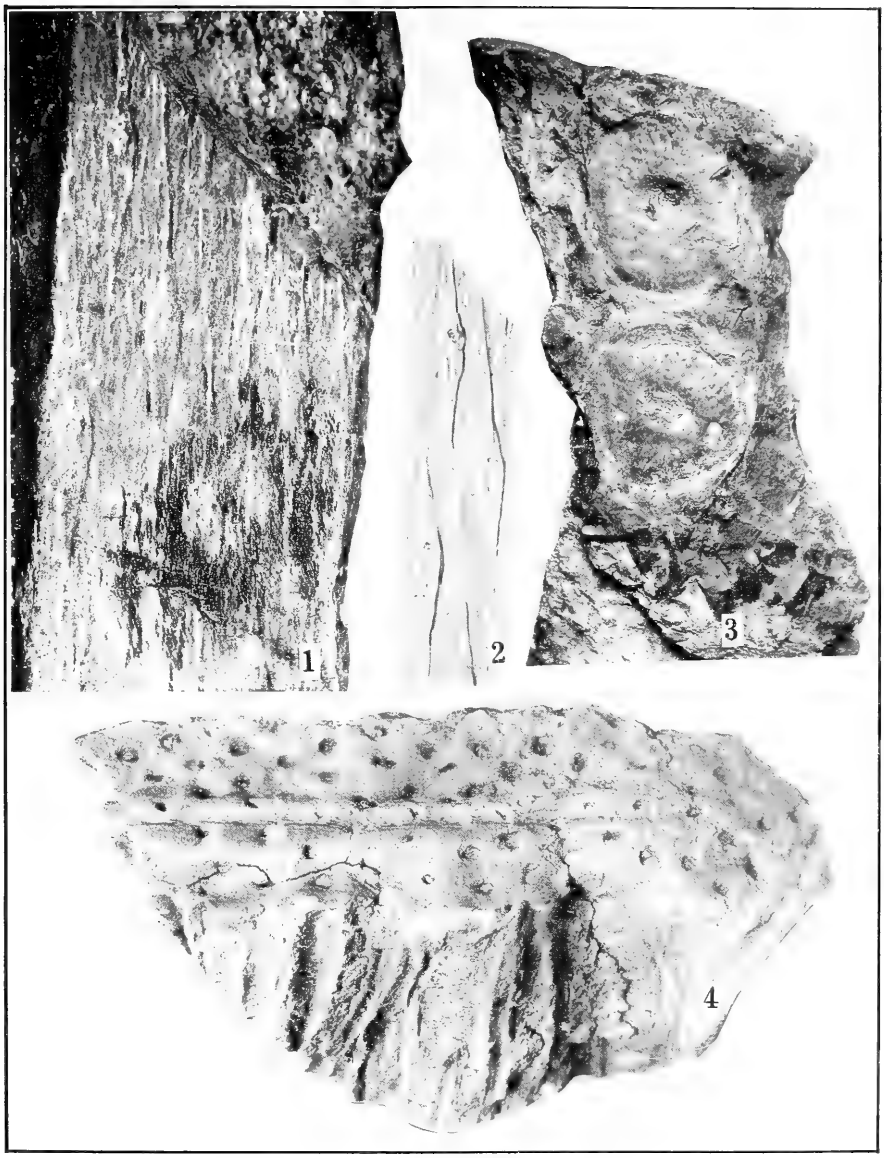
2. Silt Flats, Blackheath Glen, Megalong Valley.



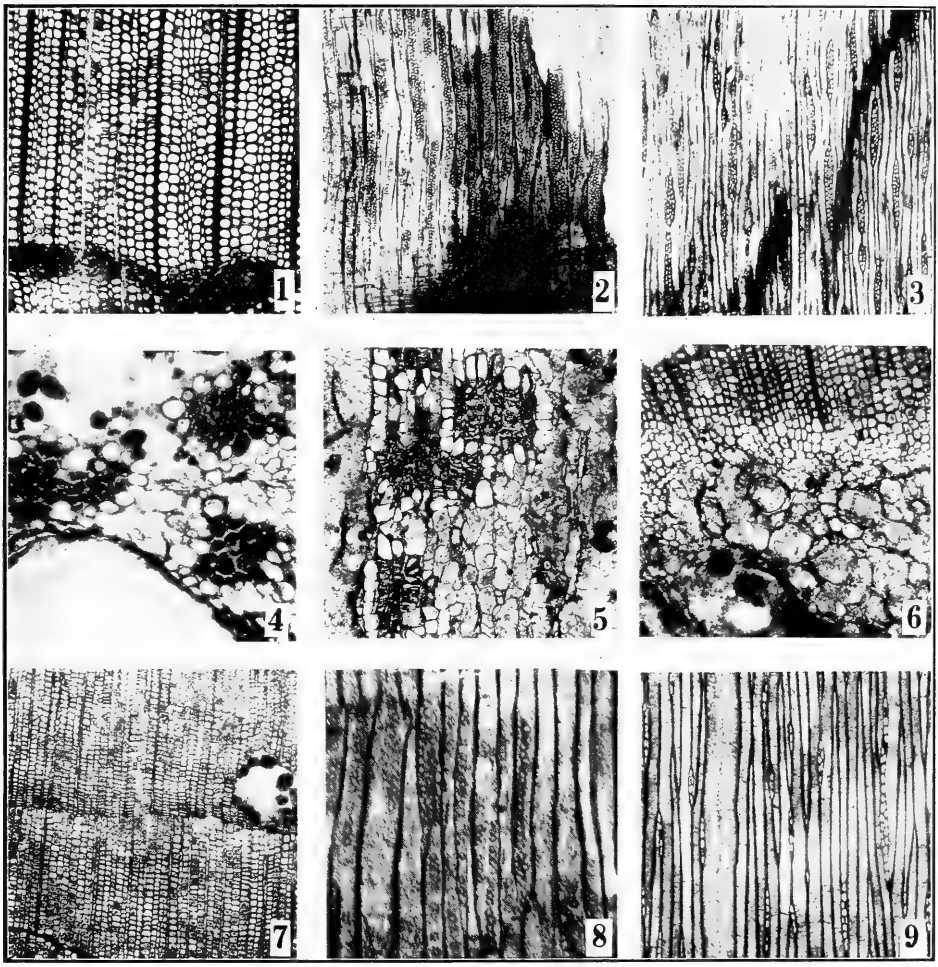
1. Walls of Green Wattle Creek.



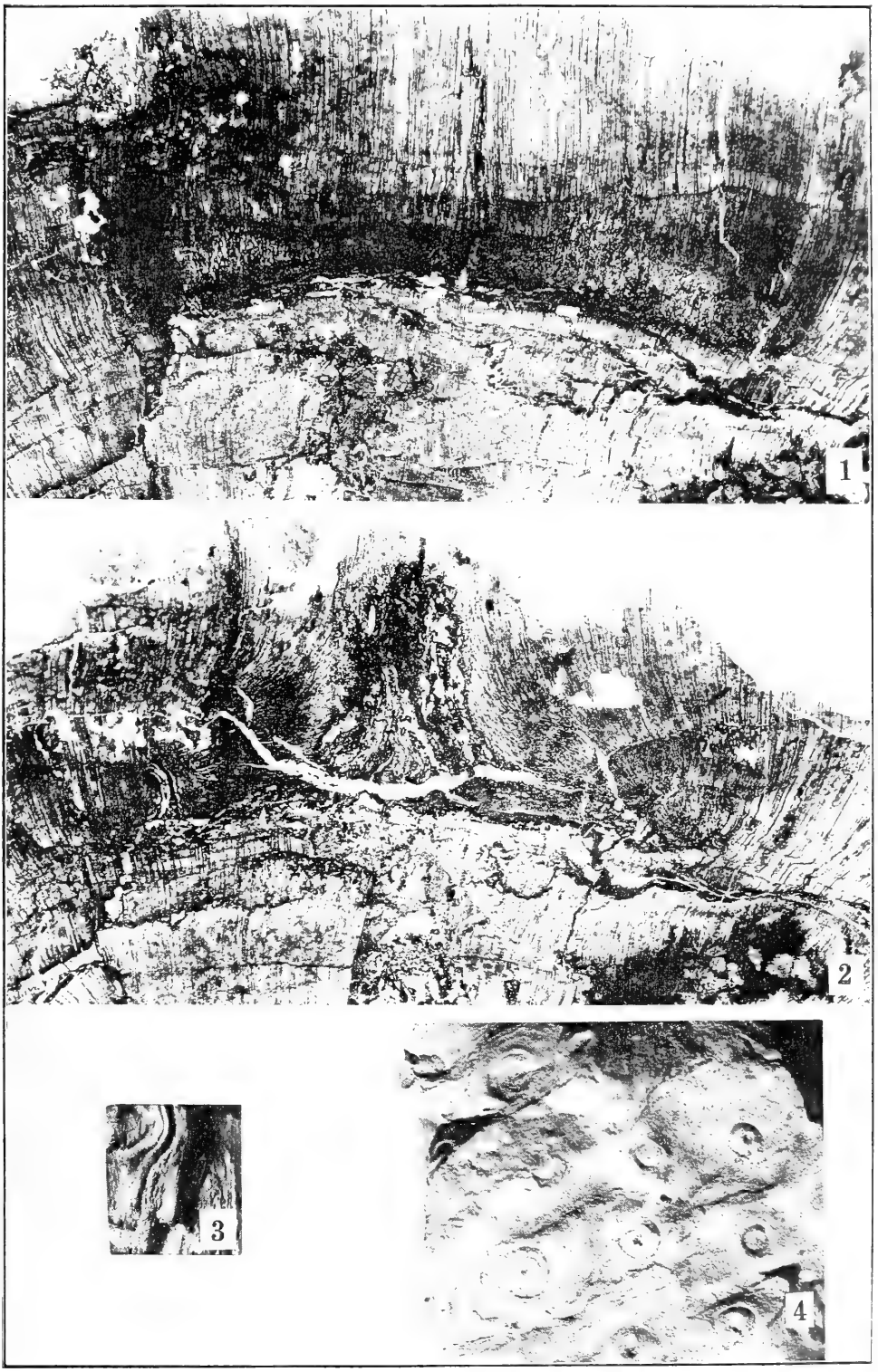
2. View of Burragorang Valley.



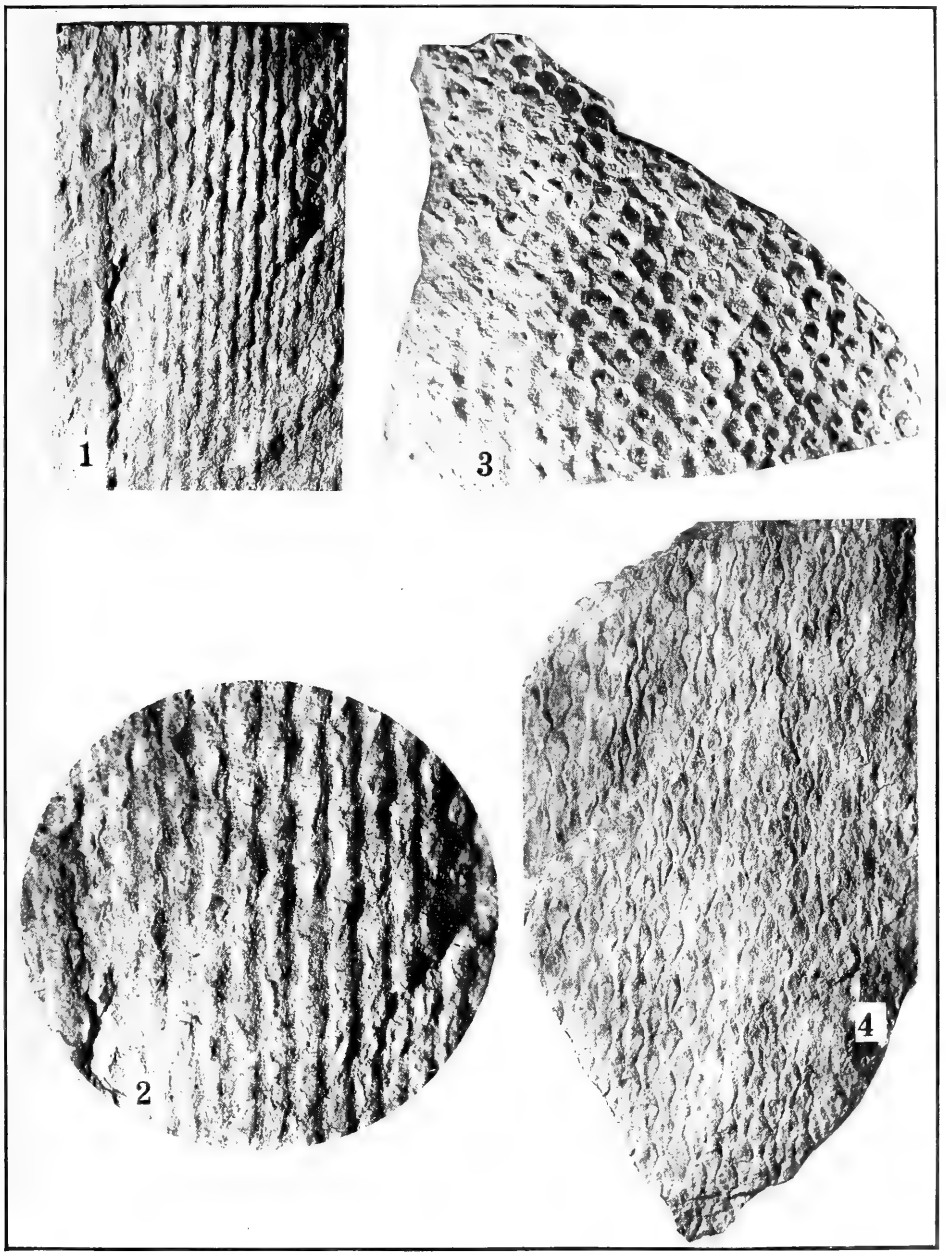
1, 2. *Lepidodendron Osbornei*. n. sp. 3. *Ulodendron minus*.
4. *Stigmaria ficoides*.



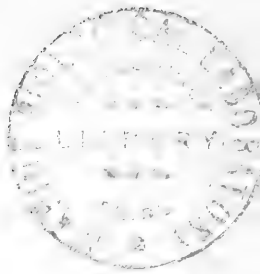
1-3. *Pitys* (?) *Sussmilchi*, n. sp. 4-9. *Dadoxylon farleyense*, n. sp.



1-3. *Dadoxylon farleyense*, n. sp. 4. *Stigmaria ficoides.*



1, 2. *Protolepidodendron lineare*, n. sp. 3. *Lepidodendron* (?) *Clarkei*, n. sp.
4. *Protolepidodendron yalwalense*, n. sp.



NOTES ON AUSTRALIAN DIPTERA, No. xv.

By J. R. Malloch.
(*Communicated by I. M. Mackerras.*)

(Five Text-figures.)

[Read 25th July, 1928.]

Family **Sapromyzidae.**

Trigonometopus (Neotrigonometopus) albibasis, n. sp.

Female.—Yellowish clay-coloured. Frons grey dusted, with the ocellar spot fuscous, and a faint dark longitudinal central line; occiput grey dusted; aristae fuscous, paler at bases; all cephalic hairs and bristles black. Thorax with four rather faint dark vittae, most evident anteriorly, the outer pair broadest; scutellum and pleura entirely pale testaceous. Abdomen not marked. Legs unicolorous pale testaceous. Wings, including the veins, at bases to just beyond humeral cross-vein and almost to apices of basal cells, white, from that point outward pale brownish hyaline, darker just beyond the white portion, the veins yellowish except at that point where the colour of wing changes. Halteres yellow.

Frons about 1·25 times as long as broad, quite copiously haired on front half and especially on angle between each antenna and eye; ocellar bristles small and fine; both pairs of orbitals long and strong, but not as long as inner pair of verticals, the latter twice as long as outer pair; postocular bristles quite long and strong, continued along cheek below eye, and practically connecting anteriorly with the series of long bristles near lower margin; parafacials narrow, with some microscopic hairs on lower half of inner margin; arista with very short pubescence; third antennal segment rounded at apex. Thorax with 1 + 2 dorsocentrals, a strong pair of prescutellar acrostichals in line with the posterior pair of dorsocentrals; two series of intra-dorsocentral hairs, no presutural present, and the anterior sternopleural very short and fine; scutellum subconvex above, edge thick, with a slight central depression, and four bristles. Legs normal. Wings as in *fuscifrons* Malloch.

Length, 4 mm.

Type, Cairns, N. Queensland, 1907 (Coll. Lichtwardt, Deutsches Ent. Inst.).

From the above species, *fuscifrons* Malloch differs in having the bristles on cheeks much more numerous and weaker, the area between antenna and eye with only one or two fine hairs, the frons deep fuscous except a narrow line on each side posteriorly, the occiput with a large subtriangular blackish mark on each side on upper half which does not extend to margin, the scutellum blackish on central basal portion, and the white area at base of wing falling short of humeral cross-vein and bases of basal cells.

I have, in a paper in the press, erected the subgenus *Neotrigonometopus* for the reception of *fuscifrons* Malloch, distinguishing it from *Trigonometopus* by the fact that the anterior of the three pairs of dorsocentral bristles is in front of the

suture. I have seen no species referable to the subgenus *Trigonometopus* from Australia.

It is incumbent upon me to correct an error in my generic key recently presented in this series of papers. Through a slip the genus *Trigonometopus* is stated to have the anterior orbital bristles incurved and *Paranomina* these bristles recurved. The reverse is the case. From *Paranomina* the species from Australia which I have referred to *Trigonometopus* may be readily distinguished by the presence of a pair of strong presutural dorsocentral bristles, the three pairs in *Paranomina* being all postsutural, and weaker.

HOMONEURA (HOMONEURA) PUBISETA (Kertesz).

I have, since sending my paper on the Australian species of *Homoneura* to the press, obtained specimens which I consider belong to this species. All the specimens are males, and the species runs down to caption 10 in my key. There is no dark central spot on any of the tergites, a character which distinguishes it from *gordoni*, and the arista is pubescent only, which distinguishes the species from *indecisa*, in which the arista is plumose. The hypopygium has a long slender heavily chitinized process on each side, evidently the outer forceps, which, when at rest, project almost straight across the venter, crossing each other and lying close against the ventral surface of abdomen. I have included this species in a key to the Oriental species of the genus and have drawn the hypopygia for inclusion in that paper.

Length 3 mm.

Locality.—Palmerston, N. Australia, November, 1908 (Coll. Lichtwardt, Deutsches Ent. Inst.). One specimen sent to Dr. Mackerras for placing in some Australian museum.

HOMONEURA (HOMONEURA) ARMATA Malloch.

In Part x of this series of papers I figured the hypopygium of what I believed to be the male of this species. Since then I have discovered that there are two very closely similar species and that I figured the wrong male. The male with the foliate and serrate edged inner forceps is evidently distinct. The process of the apical tergite, or the superior forceps, consists of two long slender curved spines in *armata*, while in *fergusoni* it consists of one, which is variously dentate or spined at apex. The inner process in *armata* consists of a tapered hook. The apical plates of the female in *armata* are tapered to tips and there more or less blackened.

I have seen this species from Seaford and Ararat, V., and Narrandera and Bourke, N.S.W.

HOMONEURA (HOMONEURA) FERGUSONI, n. sp.

Distinguishable from *armata* by the genital characters in both sexes. Figure 10 in part x of this series of papers is that of *fergusoni* and not *armata*. I find that the apex of superior forceps is quite variable in form here owing to the presence of a number of thorns, and the armature of the inner process is also rather variable, though always pronounced. The apical plates of the female are not blackened at tips and are much wider there than in *armata*.

Length, 6-7 mm.

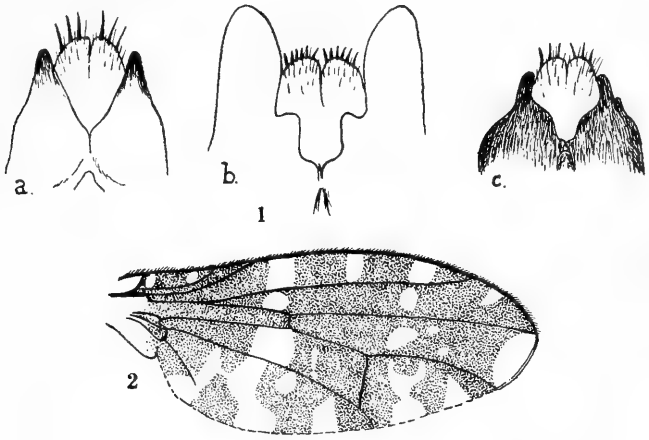
Type, allotype, and 8 paratypes, Narrandera, N.S.W., 25.3.1925-6, 6.5.1926, and 7.10.1925 (E. W. Ferguson).

Named in honour of the late Dr. E. W. Ferguson who collected the material and submitted it to me for identification.

As indicated above the species will run to *armata* in the key in part x, but it is readily distinguished from it and *perthensis* by the yellow genital plates of the female, and the structure of the male hypopygium. The genital plates in the female of *perthensis* are asymmetrical (Text-fig. 1, *b*), those of the other two species are not.

Genus TRYPANEOIDES Tonnoir and Malloch.

This genus contains at present about a dozen Oriental and one New Zealand species, to which total I am now able to add one from Australia. I included it in my generic key in part xiii of this series in the belief that some species of the genus would be discovered in Australia and the characters there cited will serve to distinguish from its allies.



Text-fig. 1.—Genital segments of females; *a*, *Homoneura armata*; *b*, *H. fergusoni*; *c*, *H. perthensis*.
Text-fig. 2.—*Trypaneoides australis*, wing.

TRYPANEOIDES AUSTRALIS, n. sp.

Male.—Head fuscous, ocellar triangle and the frontal orbits grey dusted, the latter with a brown spot at base of the upper bristle; face brownish testaceous, grey dusted, with a faint dark central mark; a brown spot below each eye; occiput and postocular orbits grey dusted; antennae, aristae, and palpi black, third segment of antennae yellowish at base. Thorax and abdomen fuscous, and grey dusted, the former with dark brown marks as follows: a vitta between acrostichals and dorsocentrals from anterior margin to third pair of dorsocentrals which connects with the spot at base of third bristle, a short vitta behind suture laterad of the dorsocentrals, a more irregular vitta over the posthumeral and supra-alar bristles, a spot at base of each hair and bristle, and a broad margin on scutellum; pleura with three oblique brown vittae; abdomen with a brown spot at base of each bristle, very large and confluent at apices of tergites. Legs dull testaceous, femora largely fuscous basally. Wings black, with clear spots (Text-fig. 2). Halteres black.

Frons at vertex wider than long; all bristles strong; arista with its longest hairs about half as long as width of third antennal segment. Thorax with 1 + 3 pairs of acrostichals and dorsocentrals, all strong, and practically no other surface hairs; mesopleura with one discal and one hind marginal bristle; both sternopleurals strong. Apices of tergites with long erect sparse bristles. Fore femur without anteroventral comb; hind femur with a strong anteroventral bristle about one-third from apex.

Length, 2 mm.

Type, Innisfail, Queensland (F. H. Taylor).

Resembles *fenestralis* de Meijere, but that species has the abdomen glossy black.

Family **Sciomyzidae.**

I have not attempted heretofore, nor yet in the present paper, a revision of the Australian species in this family, having on hand but few specimens referable to it. There is a paper by Dr. A. L. Tonnoir and the writer in the press dealing with the family in New Zealand which may prompt someone to make a study of the group in Australia, and the present is accepted as an opportune time to give a few notes on certain forms in the material now before me. A definition of the family was given in part vi of this series of papers (These Proceedings, 1, 1925, 80).

The family has been divided into three subfamilies. The Tetanurinae, with a cylindrical ovipositor, and seven abdominal segments in female, and the arista subapical, occur only in Europe as far as known now. The other two, in which the ovipositor is not strongly developed, the abdominal segments beyond fifth are more or less telescoped, and the arista is near base of third antennal segment, are almost cosmopolitan. The Sciomyzinae are distinguished from the Tetanocerinae by the presence of a distinct propleural bristle.

The Tetanocerinae are divided into several tribes, representatives of one of which are before me now.

Tribe **Sepedonini.**

This tribe is distinguished by the presence of but two scutellar bristles, the lack of a humeral bristle except in *Neosepedon*, and usually the elongated hind femora.

There are three genera recognized in the tribe, *Thecomyia* Perty, *Sepedon* Latreille, and *Dichaetophora* Rondani. A careful examination of material from various regions convinces me that it is advisable to recognize some groups of species as subgenera.

Key to the Genera.

1. The vertical area above bases of hind coxae and below base of abdomen as heavily chitinized as pleura, not depressed; metapleural callus bare; ocellar bristles lacking; none of the femora much thickened, all of them spinose below at apices; arista plumose ..... *Thecomyia* Perty (*longicornis* Perty)
   The vertical area between bases of hind coxae and base of abdomen membranous, and more or less depressed; arista short haired 2
2. Metapleural callus haired ..... *Sepedon* Latreille
   Metapleural callus without hairs ..... *Dichaetophora* Rondani

Genus Sepedon Latreille.

It is evident to me that this genus as represented by the material before me is susceptible to subdivision into at least two subgenera. One of the subgenera is

restricted to the group to which the genotype, *sphegeus* Fabricius, belongs, the other contains several American species. As the matter does not bear directly upon the Australian species I am not proposing a new name for the second segregate herein. I have seen no Australian species of either segregate.

Genus Dichaetophora Rondani.

The Australian species before me belong to this genus but do not agree in all particulars with typical species thereof. I consequently propose to erect a new subgenus for their reception, basing its definition as in the following synopsis.

Synopsis of Subgenera.

A. Ocellar bristles present but small; humeral bristle present; second antennal segment not longer than third, the latter narrowed beyond insertion of arista, its apex bluntly rounded; fore and hind femora thicker than mid pair, and spinose below; first wing vein extending beyond inner cross-vein .... Subgenus *Neosepedon*, nov.

AA. Ocellar bristles lacking; humeral bristle lacking; second antennal segment much longer than third, the latter pointed at apex; hind femur much thicker than mid and fore pairs, and more strongly spinose below; first wing vein ending proximad of inner cross-vein ..... Subgenus *Dichaetophora* Rondani

Subgenus Neosepedon, nov.

I place in this subgenus two Australian species and cite as the genotype, the first included species, *punctipennis*, n. sp.

The description and comparative notes should serve to distinguish the species.

Dichaetophora (Neosepedon) punctipennis, n. sp.

Male.—Head testaceous yellow; frons fulvous, ocellar spot and a mark against each eye near upper margin black, central glossy stripe brown; orbits narrowly white dusted on outer edge anteriorly; a dark mark between each antenna and eye; face, and especially the parafacials, densely whitish dusted; antennae brown, third segment fuscous apically; arista yellow; palpi testaceous yellow. Thorax brownish testaceous, with grey dust, the dorsum with two narrow submedian and two broad sublateral reddish-brown vittae; scutellum reddish-brown, grey dusted on sides; pleura with a brownish vitta on upper margin. Abdomen shining brownish testaceous, with posterior lateral angles of tergites grey dusted, sixth tergite grey dusted, with a pair of large shining reddish-brown discal spots. Legs testaceous yellow, apices of femora faintly, and of tibiae distinctly, infuscated, apex of third and all of fourth and fifth tarsal segments fuscous. Wings greyish hyaline, with numerous small fuscous dots, 6-8 in the cell in front of second vein beginning below apex of auxiliary vein and extending to apex of second, about three along lower side of apical section of second vein and one on costa between apex of that vein and apex of third, about ten arranged alternately on apical section of third vein, four above and six below, about the same number on apical two sections of fourth vein, and about six on fifth vein along discal cell, the spots all touching the veins.

Frons at vertex half of the head width, central glossy vitta depressed and complete; postverticals and both pairs of verticals quite long and strong; orbital represented by a short hair; second segment of antenna parallel-sided, slightly shorter than third, the latter slightly and gradually narrowed from insertion of arista to apex, the latter rounded; arista about as long as antenna, pubescent; face carinate above, slightly receding below, and with some microscopic black hairs on lower half of sides; cheek about half as high as eye, the latter slightly higher than long. Thorax

with one humeral, two notopleural, one supra-alar, two postalar, and one pair of dorsocentral, bristles; mesonotum and disc of scutellum with short hairs; mesopleura, sternopleura, centre of hypopleura and pteropleura, lower part of propleura, and the prosternal plate, with microscopic black hairs. Fore and hind femora thicker than mid pair and with short stout spines on apical half of anteroventral and posteroventral surfaces; mid femora unarmed below. Inner cross-vein close to middle of discal cell; first posterior cell slightly narrowed at apex; outer cross-vein bent outward at middle.

Length, 6 mm., exclusive of antennae.

Type and one paratype, Botany Bay, N.S.W. (H. Petersen).

This and the next species were sent to me by the late Dr. C. F. Baker of the Philippine College of Agriculture.

DICHAETOPHORA (NEOSEPEDON) CONJUNCTA, n. sp.

A specimen in poor condition differs from the foregoing in having no evident dark spot between each antenna and eye, and the wings with the dark spots along veins connected across the cells, those in apical portions of submarginal, and discal cells, and all of those in first posterior cell, furthermore connected by means of a longitudinal dark streak in centre of cells, leaving in these sections only small round clear spots along the side of each of the veins. The dark colour in the anal and second posterior cells is also in the form of clouds and there are similar small hyaline spots along the lower sides of the veins as is the case in the others just mentioned.

Length, 6 mm.

Type, Botany Bay, N.S.W. (H. Petersen).

It is possible, but hardly probable, that this is a variety of *punctipennis*, but the specimen has been badly eaten by some pest and the antennae and abdomen are lacking, so that it is impossible to determine even the sex of the specimen.

Both of these species will be sent to Dr. Mackerras so that they may be deposited in some suitable Australian museum where they may be available to anyone desiring to make a study of the family.

Subfamily SCIOMYZINAE.

The members of this subfamily are distinguished from Tetanocerinae by the presence of a distinct propleural bristle immediately above fore coxa.

I have seen two genera from Australia.

Genus HELOSCIOMYZA Hendel.

This genus is readily distinguished from any other in the family by the very prominent bristles on the costal vein. It is confined to Australia and New Zealand.

There are two Australian species known to me which are referable here. One of these is the genotype, already briefly described by me in this series of papers, and a new one which is closely related to one occurring in New Zealand. They may be distinguished as below.

A. Pteropleura bare ..... *ferruginea* Hendel
AA. Pteropleura setulose centrally ..... *aliena*, n. sp.

HELOSCIOMYZA ALIENA, n. sp.

Male and female.—Head testaceous yellow, cheeks, frontal orbits and occiput, white dusted, ocellar region and a central vitta extending beyond middle of frons,

a mark at base of outer vertical bristle, and another on middle of occiput behind each eye, dark brown; antennae reddish testaceous, third segment fuscous above and at apex; arista fuscous; palpi testaceous. Thorax testaceous, densely whitish-grey dusted, dorsum with four brown vittae, the median pair fused posteriorly and continued over disc of scutellum, the sublateral pair divided by a narrow longitudinal line behind suture; pleura brown below humeral callus. Abdomen brownish testaceous, paler at apices, darker at bases, of tergites. Legs testaceous, femora darker, fore pair grey dusted, apices of hind pair, and of hind tibiae, and apical three segments of all tarsi, blackish. Wings greyish hyaline, cross-veins slightly clouded. Halteres yellow.

Anterior orbital about half as long as posterior one, rather close to it, and not much proximad of middle of frons; anterior portion of frons sparsely black-haired; face with a slight vertical carina; cheek about as high as width of third antennal segment, sparsely haired on lower half; arista pubescent. Thorax as in *ferruginea*, with two pairs of strong postsutural dorsocentrals; propleura with one strong bristle, the stigmatal bristle also present but very short; pteropleura setulose; anterior sternopleural bristle shorter than posterior one. Male with a pair of leaf-like processes at apex of hypopygium. Legs stouter in male than in female. First posterior cell of wing not narrowed at apex.

Length, 4-5 mm.

Type, male, and allotype, Broken Hill and Sydney, N.S.W., 9.6.25.

A smaller, darker, and more slender, species than *ferruginea*, from which it may yet be distinguished at least subgenerically.

Genus Melina Robineau-Desvoidy.

I have one species before me which is referable here. Hendel uses the generic name *Graphomyzina* Macquart for the group to which it appears most readily referable, but Cresson has placed the genus as a subgenus of *Melina*. Hendel uses the genus name *Sciomyza* instead of *Melina*, basing his contention upon the refutation of the claim that Westwood actually fixed types in his 1840 paper. Most authors accept Westwood's paper as fixing types and if it is so accepted then *Melina* ought to be accorded the right to stand as the name for the present genus.

Melina, as accepted herein, is distinguished from *Helosciomyza* by the lack of long bristles on the costa. The pteropleura is setulose, the arista long haired, the fore tibia has but one preapical dorsal bristle, and the inner cross-vein is beyond the middle of discal cell of wing.

The eyes are elongate and longer than high in the only species before me, thus placing it in the subgenus *Graphomyzina*, the true *Melina* species having the eyes round, or higher than long.

I have but one specimen of this species before me and, in the hope that it may be possible for me to obtain more material in the family later, I defer describing it until such time as my collection will permit a more thorough survey of the Australian forms.

Family **Borboridae.**

Genus Leptocera Olivier.

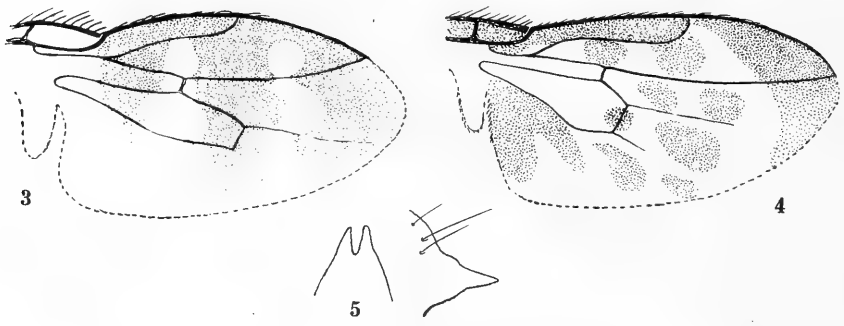
This genus has been divided into a large number of subgenera by Dr. O. Duda, the two species dealt with herein being referable to *Collinella* Duda.

LEPTOCERA (COLLINELLA) TRIFASCIGERA, n. sp.

Female.—Head dark brown, anterior margin of frons, centre of cheeks, palpi, and most of antennae, testaceous yellow. Thorax shining black, slightly grey dusted and with a faint dark central vitta on dorsum, notopleural margin and sutures of pleura yellowish. Abdomen with the dorsum unicolorous black, slightly grey dusted. Legs fuscous, knee-joints, a median band on each tibia, bases of fore tibiae, bases of fore tarsi, and all of mid and hind tarsi, fulvous yellow. Wings faintly infuscated at bases, with a rather pronounced median fascia, and a fainter one at apex, both darkest on the third vein (Text-fig. 3). Halteres yellow.

Frons strongly bristled, the ocellars long; antennae porrect, divergent, third antennal segment rounded; arista slender, distinctly short haired, and almost as long as mesonotum; one long vibrissa on each side. Lower humeral bristle downwardly directed, upper one and scapular bristle directed mesad; three pairs of postsutural dorsocentrals, becoming shorter and more widely separated anteriorly; surface hairs quite strong, about eight series between the anterior dorsocentrals; sternopleural bristle long; scutellum flat and bare above, with four long and two short (intermediate) bristles. First visible tergite as long as next two together, second about half as long as third, and subequal to fourth, the bristles fine and short. Mid tibia with two anterodorsal and two posterodorsal bristles and a ventral one near apex; basal segment of hind tarsus slightly thicker and about half as long as second. Venation as in Text-fig. 3.

Length, 1·5 mm.



Text-fig. 3.—*Leptocera trifascigera*, wing.
Text-fig. 4.—*Leptocera myrmecophila*, wing.
Text-fig. 5.—*Atherigona bidentata*, apical abdominal process of male from above and the side.

Type, Mt. Molloy, Queensland (F. H. Taylor).

This species has the wings very similar to those of *subtinctipennis* Brunetti, which occurs in India, Formosa, and some of the islands in the Indian Ocean, but that species has eight scutellar bristles. *L. myrmecophila* Knab and Malloch has the wings as Text-fig. 4.

Family **Muscidae.**

ATHERIGONA BIDENTATA, n. sp.

Male.—Head fuscous, occiput, frontal triangle, and orbits, face, and cheeks densely yellowish-grey dusted; lower portion of face testaceous; antennae, aristae, and palpi black, aristae slightly paler basally, interfrontalia dark brown. Thorax

fuscous, densely grey dusted, humeral angles and propleura yellowish, dorsum with three faint brown vittae. Abdomen fulvous yellow, more or less obscured on dorsum with grey dust basally, first three visible tergites each with a pair of black spots, very large on second, smallest on third, and on these tergites an additional faint central brownish vitta, fourth tergite and hypopygium yellow. Legs honey-yellow, apical third of fore femora and tibiae, and basal three segments of fore tarsi blackened. Wings clear, with a faint dark streak at apex of auxiliary vein. Calyptrae and halteres white.

Head of the usual form; third antennal segment long, and rather broad; arista densely pubescent, the second segment longer than thick; palpi short, and dilated at apices as in *varia* Meigen. Thorax normal; some setulae besides the three bristles on sternopleura. Abdomen slightly tapered to apex, none of the tergites excessively enlarged, the hypopygial process as Text-fig. 5. Fore femur not excavated above, with at least one preapical posteroventral bristle; fore tibia without exceptional armature; fore tarsus exceeding in length the tibia by about the extent of apical two segments, slender, and without exceptional hairing. Inner cross-vein but little before middle of discal cell, penultimate section of fourth vein about two-thirds as long as ultimate, first posterior cell very slightly narrowed at apex, outer cross-vein erect, at less than its own length from apex of fifth vein.

Female.—Similar to male, but the abdomen not so sharply marked and with a pair of small dark spots on fourth tergite, the fore legs except coxae and knee-joints black, mid and hind tarsi and hind tibiae except bases fuscous.

Length, 3·5 mm.

Type, male, allotype, and 4 female paratypes, Bellavista, Papua, 4,600 feet (D. M. Stewart).

Genus Limnina, nov.

This genus is closely related to *Limnophora* Robineau-Desvoidy, but is distinguished from it by the presence of some setulae near middle of under surface of the auxiliary vein, some microscopic hairs on base of stem vein below, and hairs on sides of scutellum which invade the ventral surface to some extent. There are several other characters which I mention in the specific description that may be of generic import, but I omit mention of these as generic criteria, lest by so doing I engender the erection of additional genera for species yet unknown to me which might differ in some of these less important characters and yet agree in the essential features already cited.

Genotype, the following species.

Limnina elongata, n. sp.

Male.—Black, with pale grey dusting on head, thorax, and abdomen. Head with silvery dust on frontal orbits and parafacials, interfrontalia velvety black when seen from behind. Thorax fuscous on disc, the lateral margins pale grey dusted, and the areas between the five blackish vittae less distinctly pale dusted, the vittae not conspicuous; disc of scutellum and upper margin of pleura fuscous, remainder of pleura blue-grey dusted. Abdomen with a pair of large deep black opaque spots on each of basal three tergites, those on second and third very narrowly separated in middle and covering almost all of dorsum, fourth with a pair of dark submedian lines and a dark apex. Legs black. Wings slightly smoky. Calyptrae white. Halteres yellow.

Frons at vertex about one-fifth of the head width, orbits linear above, widened in front, interfrontalia of uniform width throughout, frontal orbital bristles rubbed off in type, but apparently all weak; arista very short haired; parafacial linear in profile; vibrissal angle hardly produced. Thorax with 2 + 3 pairs of dorsocentrals, the anterior intra-alar lacking, and very few fine surface hairs, the presutural acrostichal area with three series of hairs; sternopleurals 1 + 2. Abdomen elongate, tapered to apex, fifth sternite about twice as long as fourth, projecting beyond apex of hypopygium, transverse at apex, and with a small central wedge-shaped notch in centre. Fore tibia without a median posterior bristle; mid tibia with one median posterior bristle; hind femur with a preapical anteroventral bristle; hind tibia with one anteroventral and one anterodorsal median bristle. Inner cross-vein at one-third from apex of discal cell; fourth vein but slightly bent forward apically; third vein setulose at base both above and below.

Length, 5 mm.

Type, Bellavista, Papua, 4,600 feet (D. M. Stewart).

This specimen as well as those collected by Mr. Taylor recorded in this paper were sent to me by Dr. A. H. Baldwin of the Australian Institute of Tropical Medicine, and the types will be returned to him for disposition in Australia.

Genus Limnella, nov.

This genus is erected for the reception of *Limnophora orthoneura* Malloch and is distinguished from *Limnophora* by the presence of short setulose hairs on the upper surface of the first vein. The eyes of the males are widely separated above, which is very rarely the case in *Limnophora*, and never the case in *Myiographa* Malloch which latter has the first vein setulose above also. In *Limnella* the fourth vein is not at all forwardly curved, while in *Myiographa* it is very conspicuously curved forward.

At present I have referred but one species to this genus, though it is probable that more will be discovered in the Australian region.

Family **Calliphoridae.**

Genus Melinda Robineau-Desvoidy.

There is before me one species which I refer to this genus. It closely resembles the European *polita* Macquart, and is about the same size.

Melinda minuta, n. sp.

Male and female.—General colour aeneous black, the whole slightly grey dusted and distinctly shining, mesonotum with four narrow black vittae, the submedian pair continued a little behind suture, the lateral pair broken in front of suture and wider there than behind it. Abdomen metallic greenish-black, with white dust, the dorsum with a faint narrow dark central vitta. Legs black. Wings greyish hyaline. Calyptrae whitish. Halteres yellow.

Eyes bare; narrowest part of frons about 1·5 times as wide as third antennal segment; parafacial as wide as third antennal segment, haired on upper half; facial ridges setulose on lower halves; third antennal segment fully twice as long as second; arista plumose on basal half or more; vibrissal angle slightly produced; cheek fully twice as high as width of parafacial. Thorax with 2 + 3 dorsocentrals, 2 + 2 or 3 acrostichals, the posterior one of the sublateral bristles lacking, and the anterior one microscopic or absent. Abdomen narrowly ovate, bristles on apices of

third and fourth visible tergites, and on middle of fourth well developed; sternal hairs setulose and moderately numerous. Leg bristles as in *Calliphora* species. Inner cross-vein a little beyond apex of first vein and about two-fifths from apex of discal cell; outer cross-vein close to midway between inner and bend of fourth; first posterior cell closed, and with a short petiole.

Female.—Frons at vertex a little less than one-third of the head width, widened to one-third at anterior margin. Thorax more greenish than in male and with the median vittae more noticeably continued to behind suture, the postsutural acrostichals in type five in number. Abdomen broader than in male, and with slight evidences of checkering in the dusting. Tibiae a little brownish. Inner cross-vein a little closer to middle of discal cell, outer a little beyond midway from inner to bend of fourth.

Length, 3·5-4 mm.

Type, male, and allotype, Como, N.S.W., December, 1923, swept from flowers (H. Petersen).

The male of *polita* which I have examined has the frons narrower than the above species, and the second abdominal tergite with a pair of strong bristles on middle of hind margin, and another pair on disc of third segment.

The above description was inadvertently omitted from the paper on this family recently published by the writer though written at the same time as the others which appeared therein.

Genus Huttonobesseria Curran.

In a paper recently published by Mr. H. C. Curran in Europe this genus is erected for the reception of the species described by the late Capt. Hutton under the name *Gymnophania pernix*.

I have had an opportunity of examining a specimen of this species and find that it belongs to the Calliphoridae, and not to Tachinidae where both Hutton and Curran have placed it. The lack of a developed postscutellum inevitably prevents it from being considered as referable to Tachinidae, and though the arista is pubescent only, it is without question close to *Melinda*.

It is a glossy black species with black legs and, being without setulae on the posterior side of the stem vein above, falls into the segregate above indicated, but the lack of long aristal hairs readily distinguishes it from any related genus occurring in Australia.

So far as known at present the species occurs only in New Zealand.

Genus Paurothrix Bezzi.

This genus was erected for the reception of two Samoan species. It has much the appearance of *Melinda*, but one of the species has a few hairs on the supra-squamal ridge; the other lacks these. The upper part of the parafacials is bare and so also is the disc of lower calypter. The posterior sublateral bristle is absent, a character which distinguishes it from *Luciliella* Malloch.

I have seen only females sent to me by Dr. Buxton for examination.

Family Tachinidae.

Tribe Ameniini.

When I wrote my previous paper dealing with this tribe I did not have before me the genus *Paramenia* Brauer and von Bergenstamm, but subsequently I had an opportunity to examine it in the United States National Museum. The principal

characters distinguishing it from *Amenia* and *Stilbomyia* are the non-carinate face, and the bare prosternum and central portion of propleura. The anterior posthumeral bristle is also slightly mesad of the posterior one.

The three genera may be separated as below. *Microtropeza* Macquart is still unknown to me. If it belongs to the tribe Ameniini it may be distinguished from the others by the non-carinate face, and the bare arista, as well as its less evident metallic coloration.

Key to the Genera.

1. Face not carinate; prosternum and central portion of propleura bare .... *Paramenia* Brauer and Bergenstamm
   Face conspicuously vertically carinate in middle; prosternum and central portion of propleura haired 2
2. Frons of male much narrower than that of female, and without strong forwardly directed supra-orbital bristles; height of cheek always decidedly greater than length of antenna ..... *Amenia* Robineau-Desvoidy
   Frons of male not narrower than that of female, and in both sexes with two or more strong forwardly directed supra-orbital bristles ..... *Stilbomyia* Macquart

Genus Paramenia Brauer and Bergenstamm.

This genus is the same as *Calliphoropsis* Townsend, and the genotype, *semiauriceps* B. and B., is the same as *Musca maculatis* Walker, the genotype of *Calliphoropsis*, as identified by Townsend.

Paramenia agrees in the structure of the postscutellum with the other two genera included in the tribe by me, and has the abdominal sternites quite broadly exposed at apices, broadly V-shaped. It has even more evidences of relationship to the Calliphoridae than have the other two genera, the head being quite similar to that of some species of *Calliphora*, except that the parafacials are bare. The anterior posthumeral bristle is slightly mesad of the posterior one, and the inner cross-vein of the wing is below a point about midway between apices of auxiliary and first veins.

Paramenia maculatis (Walker).

This is the only species known to belong to the genus. It has the frontal orbits and upper half of parafacials white dusted, the lower half of parafacial and the entire cheeks golden yellow dusted; antennae black; palpi fuscous. Thorax and abdomen deep metallic blue, with violet reflections, the former whitish dusted, most densely so on notopleural and supra-alar regions, and with a large white dusted spot on the mesopleura and another on the sternopleura; abdomen with a conspicuous white dusted spot on each side of second tergite, and an even larger one on each side of fourth; wings darkened at bases; calyptrae black, whitish at bases.

Arista plumose; face not carinate; each orbit with two strong forwardly directed supra-orbital bristles in female. Thorax with 2 + 3 dorsocentral bristles, presutural acrostichals rather inconspicuous, prescutellar pair strong. Strong bristles present only on apices of third and fourth abdominal tergites, apex of latter transverse. Fore tibia with some short anterodorsal bristles basally.

Length, 11-15 mm.

Locality.—Buderim Mt., Queensland.

Tribe **Rutiliini.**

When I wrote my previous paper, already referred to, I had available only the specimens in the collection of the United States National Museum, but I have

now had an opportunity to examine the species in the collection of the Deutsches Entomologisches Institut, through the kindness of Dr. Walther Horn, and I am thus able to present data upon many species previously unknown to me.

Genus Rutilia Robineau-Desvoidy.

A very careful examination of all the species now before me shows that the prosternal plate is not invariably bare. In some species it is absolutely devoid of hairs, in some others it is apparently so, but there are some hairs on the membranous region surrounding the anterior portion of the plate and these appear so at times that they seem slightly to invade the latter, while in a few species the hairs actually are situated upon the lateral margins of the plate as well as on the contiguous membranous region.

Below I present a synopsis of the 16 species now available to me, including therein a number of those submitted by Dr. Horn, and as these were used by Dr. Engel in his recent work on the group there is a great probability that the identifications are correct, except in one or two cases which are dealt with in the notes on the species involved.

Key to the species.

1. Hind tibia with one or two prominent bristles and no uniform fringe of closely placed regular short bristles on anterodorsal surface 2
   Hind tibia with a fringe of closely placed, quite regular, short bristles on the anterodorsal surface, and very rarely one of these bristles beyond middle slightly longer than the others 3
2. Thoracic dorsum metallic blue-green, with four black vittae, the areas between the vittae in front of suture white dusted, and in addition with the following conspicuous white dusted markings: presutural lateral margins, a spot between these and the presutural white vitta just in front of suture, a larger one in line with it behind suture, and an elongate spot on each side of median line near posterior margin; abdomen of male brownish-yellow, coppery at apex, with a black dorsocentral vitta, and blackish apices to tergites, the most evident white dust being on sides of second tergite and a submedian mark on each side of third segment; abdomen of female blackish-green, the black and white markings as in male, but more extensive, and the fourth tergite conspicuously white dusted on sides ..... *leucosticta* Schiner
   Thoracic dorsum brownish fuscous, with slight whitish dusting, which is nowhere disposed in spots, and four dark vittae anteriorly; abdomen brownish-yellow, greenish apically, with a dark dorsocentral vitta and dark apices to tergites ..... *vivipara* (Fabricius)
3. Distance from mouth margin to apex of third antennal segment not more than three-fourths as great as length of that segment ..... *inornata* Guérin
   Distance from mouth margin to apex of third antennal segment distinctly greater than length of that segment 4
4. Face, cheeks, parafacials, and frontal orbits, brownish or fuscous, rarely testaceous, and pale grey dusted 5
   Face, at least the anterior and upper portions of cheeks, and the parafacials, testaceous yellow, or orange-yellow, with bright yellow, and not grey, dust .. 12
5. Length averaging 20 mm. or more; thorax dark metallic blue-green, with quite distinct white dusting, the dorsum with four slender black vittae anteriorly; abdomen bright metallic green, with a central vitta and apices of tergites 2 and 3 black, the green portions of these two tergites with white dust when seen from behind; parafacials haired to about midway from base of antennae to lower margin of eyes; pleural hairs all black; wings hyaline, with a black fascia near bases ..... *regalis* Guérin
   Length averaging less than 20 mm.; thorax and abdomen not coloured as above .. 6
6. Thorax and abdomen similarly coloured on dorsum, uniform deep metallic blue-green, very like some of the large species of Luciliini, the thorax with slight dust and very faint traces of four blackish dorsal vittae, the abdomen with a

faint blackish dorsocentral vitta and even fainter dark apices to tergites 1 to 3; wings greyish hyaline, with a dark fascia near base, and all the veins narrowly margined with dark brown; no outstanding bristle on vibrissal angle; pleural hairs entirely black; calyptrae fuscous, darker on the margins; parafacials not haired below middle of eyes ..... Samoan species

Thorax and abdomen usually dissimilarly coloured, or neither uniformly dark metallic blue-green; the wing veins either without a trace of dark clouding, or if there is any such present it is very faint and yellowish 7

7. Pleural hairs all black or fuscous 8

Pleural hairs mostly or entirely pale, yellowish 9

8. Thorax black, the dorsum with a coppery tinge, abdomen nowhere brilliant metallic blue or blue-green ..... *viridinigra* Macquart.

Thorax and abdomen brilliant metallic blue-green or green, with distinct black markings 13

9. Prosternum absolutely devoid of hairs both close against the anterior lateral margins of the chitinized plate and on the two large lateral subvertical anterior membranous areas; species about 18 mm. in length; general colouration of thorax and abdomen brownish testaceous, the thorax almost fuscous and without any metallic sheen, mesonotum rather densely grey dusted and with four quite distinct dark vittae; one quite prominent bristle amongst those on vibrissal angle; parafacial hairs not descending below level of second antennal segment .... *desvoidyi* Guérin.

Prosternum with hairs either on the region along each anterior lateral margin of the chitinized plate or on the two large lateral subvertical anterior membranous areas, in the latter case the hairs are fine, pale and adherent to the surface so that they are visible only when the head is pressed upward well clear of the anterior margin of the thorax; species not more than 16 mm. in length; the thorax always more or less evidently metallic green or blue-green on dorsum .. 10

10. Some conspicuous long bristly hairs on prosternum contiguous to anterior lateral margins of the chitinized plate, none on the large subvertical anterior membranous areas; one moderately well developed bristle amongst the finer series on each vibrissal angle; legs fuscous; dorsum of thorax quite evidently metallic green, the surface whitish dusted, and rather faintly quadrivittate; scutellum testaceous; abdomen in both sexes testaceous or brownish-yellow, with a dark dorsocentral vitta and, at least in the female, with a faint dark apex to each tergite, fourth tergite in male with, in female without, a metallic green tinge; dorsum of thorax very largely white haired in front of suture, and entirely black haired behind it ..... *pellucens* Macquart?

The prosternal hairs very fine and almost entirely decumbent, confined to the two large anterior subvertical lateral membranous areas; dorsum of thorax with black hairs both in front of and behind suture 11

11. One of the bristles on each vibrissal angle quite noticeably longer than the others; thorax quite brilliantly metallic green or blue-green, with whitish dust and four dark vittae on dorsum; scutellum concolorous with mesonotum; legs fuscous; abdomen testaceous or brownish testaceous, with a black dorsocentral vitta and apices to tergites, the surface coppery or golden tinged, and apex of fourth tergite in both sexes brilliant metallic green ..... *lepida* Guérin

None of the bristles on vibrissal angles outstandingly developed; thorax not very conspicuously green, the scutellum usually more or less noticeably testaceous, and paler than mesonotum; abdomen in male rather inconspicuously greenish tinged, in female without green colour, legs testaceous or tawny yellow .... Samoan species

12. Pleural hairs nearly all bright golden-yellow; thorax bright metallic green or blue-green, without white dusted spots on dorsum or pleura; fourth abdominal tergite of female not impressed at apex in centre; raised portions of the cheeks opalescent green; parafacials haired to lowest level of the eyes .... *formosa* Robineau-Desvoidy

Pleural hairs all black or fuscous 13

13. Thorax violet-black, metallic bluish on the posterior margin and scutellum, with a white-dusted blue-tinged spot on each humerus and another on each side behind suture on mesonotum, pleura with only one white spot, on mesopleura; abdomen concolorous with thorax, second and third tergites each with a transverse series of four small round white-dusted blue-tinged spots, and fourth with

a pair of much larger similarly coloured marks; the black sub-basal fascia on wing as dark from beyond humeral vein to base of wing in costal cell as at any other portion; both calyptrae white at bases, blackish at apices; hairs on anterior third of frontal orbits, the parafacials, and cheeks, golden-yellow, prosternal hairs strong and black ..... *argentifera* Bigot

Thorax largely metallic blue or green on disc, if violet-black then with two presutural green vittae; the abdomen never with four small round white-dusted spots on second and third tergites, the outer pale mark always transverse when there is a small submedian pale spot on each side of median line 14

14. All hairs on frontal orbits, parafacials, and cheeks, dark, either black or fuscous, those on parafacials quite dense and conspicuous, continued broadly to lower level of eye, the three portions mentioned with more or less dense grey dusting, especially noticeable in the female, the face, parafacials, and anterior half of cheeks, testaceous yellow; thoracic dorsum metallic blue or blue-green, with four black vittae, the submedian pair extending to or slightly beyond suture, the sublateral pair a little broader and complete when seen from certain angles; abdomen brilliant metallic green, with a complete, rather broad, dorsocentral black vitta and black apical margins to the tergites except fourth, the latter extended forward at a little distance from the central vitta in male, and on third tergite usually reaching anterior margin, leaving a small submedian green spot as in *splendida* ..... *imperialis* Guérin

All hairs on cheeks and all, or almost all, of those on parafacials golden-yellow, all or most of those on frontal orbits dark in colour 15

15. Dorsum of thorax absolutely without distinct white dusting except an inconspicuous patch on each humerus 16

Dorsum of thorax quite conspicuously white dusted, with two or more pale spots on each lateral margin 17

16. Humeral angles rather inconspicuously, but quite evidently white dusted when seen from behind; mesopleura also faintly white dusted centrally; sub-basal dark mark on wing black and conspicuous, continued along costa to base of wing ..... *nitens* Walker?

Humeral angles and centre of mesopleura not at all white dusted; sub-basal dark mark on wing brownish and inconspicuous ..... Ceylon species

17. Dorsum of thorax mostly shining black, with two narrow submedian presutural vittae, and four spots on each lateral margin, green, and white dusted when seen from behind ..... *erichsoni* Engel

Dorsum of thorax mostly metallic blue or blue-green, with four shining black vittae, the intervening areas white dusted in female when seen from behind, the submedian dark vittae not complete; lateral margins of mesonotum each with four white-dusted spots, the pair at suture sometimes very faint .. *splendida* Donovan

In the case of species included in my previous paper which appear to require no further elucidation, I do not add to what I have already published, but the species which are not included in that paper are dealt with herein to a greater or less extent in order that they may be rendered recognizable to students of the group.

I have listed in the key two species from Samoa which will be dealt with in a paper on the Diptera of Samoa, and also one species from Ceylon sent to me by Dr. W. Horn, which I am unable to identify at this time. I merely introduce these species in the key to indicate specific characters which may serve to distinguish also some of the Australian species as yet unknown to me.

Rutilia vivipara (Fabricius).

The specimen I accept as *vivipara* has some hairs on prosternum close to anterior margin of the plate. The pleural hairs are yellow except the pteropleural tuft and those on disc of mesopleura. The parafacial is haired to opposite apex of second antennal segment.

RUTILIA REGALIS Guérin.

The largest species of the genus I have seen. It is very dark metallic blue or blue-green on dorsum of thorax and abdomen, the former is whitish dusted but without conspicuous lateral white spots, and has four dark vittae, the submedian pair discontinued at or just behind the suture; the abdomen has a narrow black dorsocentral vitta and black apices to the tergites, broadest apically. The head is black, with whitish dust, and the hairs are black except those on occiput, which are white. Pleural hairs black; anterior spiracle pale brown.

Parafacials haired almost to lower margin of eye; antennae short, about half as long as height of cheek. Two or three pairs of short acrostichals before suture; hind margin of mesonotum with about eight bristles; prosternum haired in front of anterior margin of plate; scutellum flattened above, subtriangular, with about 18 bristles. Sometimes one or two short bristles at apex of second visible tergite centrally. Hind tibia with a regular anterodorsal fringe of short bristles.

Length, 20-22 mm.

Queensland and New South Wales.

I have examined specimens identified by Dr. Engel, and some in the United States National Museum which were identified as *formosa* by Coquillett and, as that species, used as the genotype of *Chrysorutilia* by Townsend. The species is a true *Rutilia*.

RUTILIA VIRIDINIGRA Macquart.

I am accepting as this species the one identified as such by Engel, a female specimen of which I have before me. It is quite similar to the preceding one, but is smaller in size, averaging less than 18 mm. in length, and is darker in colour, the thorax especially being less noticeably metallic green, and the scutellum more brownish. The mesonotum is less strongly bristled than in *regalis*, with but one pair of weak presutural acrostichals, and the scutellum has fewer bristles (14).

Three specimens identified as *desvoidyi* in the United States National Museum (one by Bigot) were accepted as correct by me when I wrote my previous paper. These differ from the specimen identified by Engel in being more pronouncedly green, and in having the abdomen, especially in the male, largely translucent brownish at bases of the tergites.

RUTILIA DESVOIDYI Guérin.

I am accepting as *desvoidyi* the female before me so identified by Engel. There are three similar specimens in the United States National Museum, one of them with a rather noticeable bristle in the anterodorsal series of setulae on hind tibia.

There is some doubt as to the correctness of Engel's identification of this species as he confused with it the male of a species of the genus *Formosia*, which rather closely resembles it in colour. I shall deal with this genus later.

RUTILIA LEUCOSTICTA Schiner.

A very pretty species, with the thorax marked as in *splendida* except that there are two white-dusted spots on hind margin of the mesonotum. The male and female before me present a striking difference in the colour of the abdomen, the former having it largely brownish testaceous, with a broad dorsocentral vitta and narrow apices to the tergites black, while the female has the ground colour coppery or greenish, and the black portions much more extensive, the third tergite being black, with a pair of small submedian white dusted spots, and the

fourth tergite black, with the sides very broadly white dusted. The two white-dusted pleural spots are very conspicuous. The face and cheeks are yellow, densely golden yellow dusted, and with yellow hairs.

The hairs on the parafacial in the male descend sparsely almost to lower level of eye, but in the female they are invisible below level of apex of second antennal segment. The scutellum is slightly convex on disc and there are, besides the six or eight marginal bristles, four to six other weaker bristles slightly anterior to them.

The specimens before me are from New South Wales.

RUTILIA PELLUCENS Macquart.

Some specimens doubtfully referred here resemble small examples of *desvoidyi*, but the thoracic dorsum is more greenish than in that species, the base of costa is more evidently produced forward, or humped out, and in the characters cited in key it differs also.

Length, 12-14 mm.

Locality, Cairns, N. Queensland (J. F. Illingworth).

RUTILIA LEPIDA Guérin.

This species has much the appearance of *formosa*, but the head is brownish, with whitish-grey dust on cheeks, parafacials, and frontal orbits, and dark hairs on the two last, as well as on a portion of the mesopleura.

I have seen only Queensland specimens.

RUTILIA IMPERIALIS Guérin.

This species rather closely resembles *splendida*, but may be readily separated by the characters listed in the foregoing key.

I have seen only specimens from New South Wales.

RUTILIA NITENS Walker.

A small species belonging to the *splendida* group, the identity of which is in doubt.

TERRESTRIAL ORCHIDS OF BARRINGTON TOPS, N.S.W.

By the Rev. H. M. R. Rupp, B.A.

(Five Text-figures.)

[Read 29th August, 1928.]

On January 18, 1928, I left Eccleston, with the late Mr. John Hopson as guide, for an excursion to the Barrington Tops in search of orchids. I had described (These Proc., li, Part 3, 1926) a new species, *Diuris venosa*, from specimens brought to me, and I was anxious to examine this plant in its natural surroundings. Imperfect material of other orchids from the same locality which had come into my hands increased my desire to investigate at first hand, and I also wished to test an opinion I had formed, that a careful examination of this somewhat isolated plateau at an elevation of 5,000 feet might disclose the presence there of orchids hitherto regarded as purely southern forms.

From the point of view of a botanist, the Barrington Tops plateau may be described as consisting of low hills (which are, of course, the summits of the whole range of mountains) divided by broad grassy or swampy moors, which are traversed by streams that give birth to half a dozen rivers.

We were compelled to make the ascent from the Allyn River with as little delay as possible, for bad weather was threatening, and I was therefore unable to make a careful search of the mountain slopes until we came down. Epiphytes were visible in the lower brushes, but *Cleisostoma tridentatum* was the only one flowering. Higher up I found one or two fine racemes of *Dipodium punctatum*, and in one place *Chiloglottis reflexa* (presumably) was showing small buds.

The first orchid I saw on the plateau proved to be Fitzgerald's *Pterostylis coccinea*. In many specimens the beautiful reddish tint, which does not seem to be always present, was very marked. Moore and Betche record this species from Grafton—a surprising locality for what appears to be characteristically a highland orchid. Next came *Gastrodia sesamoides*, *Prasophylum brevilabre*, and another *Pterostylis*, referred to below. *Gastrodia* proved to be abundant, extending to the highest elevations. The Barrington form is very robust, and one plant was almost exactly 3 feet in height.

After passing Carey's Peak (5,260 feet) we went down a gentle slope to the moors of the Upper Barrington River. Among the innumerable flowers that studded these moors, I recognized *Diuris venosa* (Text-fig. 1). In my former text-figures of this species, drawn from scanty material, the labellum appears relatively narrow. While this is not exactly incorrect, I should now say that the typical form has a decidedly broad labellum, the colour of which ranges from the palest lilac to dark purplish-brown. The veining on the surface of the lamina is irregular and often absent, but it is constant and very striking on the back of all segments except the lower sepals. The flowers have a somewhat nodding habit, and are delicately fragrant. On the authority of a friend I had described the plant as

occurring "in bogs and wet places," but I can hardly confirm this. It grows in great profusion on these moors, often near the swamps, but quite as frequently well back on rising ground. It does not extend to the hillsides.

Even more abundant than *Diuris venosa* was Dr. Rogers' *Prasophyllum odoratum*. This species seems to have an extensive range, having been confused with *P. patens* for many years. In one or two details the Barrington Tops flower does not conform to the type, but the differences hardly justify any separation. *P. odoratum* is an attractive Prasophyll, and its fragrance perfumed the very air in some places on the Barrington moors. Like the Diuris, it does not seem to extend to the hillsides. *P. brevilabre* is more generally distributed, but is nowhere in great quantities. On the margins of the swamps and in boggy places, *Thelymitra venosa* was abundant. A hope I had entertained of finding the Blue

Text-fig. A.—A typical moor on Barrington Tops. (Photograph lent by P. Laney.)

Mountains form of this species was not realized, though the Barrington form is hardly typical. Dr. Rogers has made the following comment on it: "The lateral appendages of the column are barely involute, and the beak of the anther is more or less depressed and does not appear to be bifid". Equally abundant, and rarely far from water, was a rather robust and almost leafless form of *Pterostylis parviflora*, with very dark red-brown flowers. This species exhibits some perplexing variations in habit and season, and I am not satisfied of the identity of one or two forms at present included under it.

On our second day on the plateau three orchids of great interest were found. The first was Lindley's *Chiloglottis Gunnii*, the presence of which (in abundance) confirmed my opinion that southern orchids might occur on these northern highlands. So far as I can learn, this species has not been previously recorded north of the Australian Alps, which lie some 350 miles to the south of Barrington Tops. The Barrington plant appears to conform in all respects to the southern type; the flowers are of good size and colour, and elongation of the fruiting stalk is well marked. Many plants were growing in sphagnum at the mouths of gullies dis-

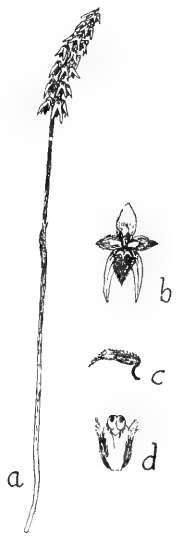
charging into the moor-swamps, and only these were flowering. Leaves were abundant in places on the hillsides, without flower or fruit, and it is just possible that they belong to another species. The second discovery was made above the mouth of the gully where the *Chiloglottis* was found. In the sphagnum numerous solitary leaves invited further investigation; and a careful search brought a few fruiting stalks and some very withered flowers of Fitzgerald's rare *Adenochilus Nortonii*, hitherto only known in a few Blue Mountains localities. It is not impossible that the Barrington plant may prove to be distinct, for the fragmentary specimens obtained (Text-fig. 2), while leaving no room for doubt as to the generic character, are of little use for further determination. Since *A. Nortonii* is the only known species in Australia, we may leave it at that for the present. I should say that the Barrington plant would probably be found flowering in November.

Text-fig. 1.—*Diuris venosa* Rupp (× ½). Barrington Tops.
Text-fig. 2.—Leaves, fruiting stalk, and withered flowering stalk of *Adenochilus* from Barrington Tops. (× ½).

At the mouth of the next gully, and practically growing in water, was a large colony of the fine *Pterostylis falcata*—another species hitherto supposed to belong to the south. I think that its discovery on Barrington Tops should be credited to the late Professor Launcelot Harrison. In a letter written shortly after the University excursion to this locality in 1925, Professor Harrison told me that he

believed he had found *P. Baptistii* on the plateau; but he had lost his specimens. I have no doubt that the supposed *P. Baptistii* (a lowland plant of warm climates) was really *P. falcata*; and the Professor wrote to me only a few days before his death, accepting this view. Among all our "Greenhoods" in Australia, *P. falcata* is the only serious rival to *P. Baptistii* in the size of the flower, and the two plants have much in common superficially. I had last seen *P. falcata* in bogs near Mt. Barrow in Tasmania, and there seem to be no differences of importance between the northern and the southern form.

3



4

Text-fig. 3.—The Barrington Tops *Pterostylis decurva* Rogers (*b*), compared with *P. obtusa* R. Br. (*a*) and a typical *P. decurva* (*c*). (× ⅓).

Text-fig. 4.—*Prasophyllum Ruppii* Rogers, from the mountain-slopes below Barrington Tops. (*a*) Plant (× ½); (*b*) Flower opened up, from the front; (*c*) Labellum from the side; (*d*) Column from the front. (*b*), (*c*), (*d*) variously enlarged.

Another *Pterostylis* abundant on the plateau was *P. cycnocephala*. This brings us to the last member of the genus which I found—alluded to above as having been seen soon after we reached the plateau. In 1926 Mr. Charles Barrett brought me a few half-pressed specimens of this plant, which I took to be a leafy form of Dr. Rogers' *P. decurva*. Mr. W. H. Nicholls and others pointed out that it seemed to differ in some important respects from the type of that species, and I was glad to have the opportunity of inspecting it *in situ*, and of collecting ample material for examination (Text-fig. 3). It is very plentiful on the hillsides, and ascends to the very summit of Carey's Peak; I also traced it down the mountain-slopes to 3,500 feet. Dr. Rogers and other workers have carefully examined the material sent by

me, and I have done the same with a large number of specimens. It appears to vary so greatly, even in this restricted area of Barrington Tops, that we do not think it wise at present to separate it from *P. decurva*. Some of the large plants show apparently constant features which would appear to justify separation, but they are linked up with almost typical *P. decurva* by numerous intermediates; and until more exhaustive investigation is made on the spot, it is better to include it under this species than to give cause for confusion by attempting to raise it to specific rank.

Thelymitra ixioides was nearly past flowering. This plant does not grow tall here, but the flowers are even larger than the type. *Microtis parviflora* was fairly common in many places. A few undoubted *Corysanthes* leaves were found, but they were insufficient for identification. In a marshy depression on a hillside some distance down the Barrington Valley from our camp, there was a *Prasophyllum* which seemed distinct. It was a moderately tall plant with greenish flowers, just perceptibly perfumed. It is described below under the name *P. Rogersii*.

During our descent from the Tops, in one of the higher *Nothofagus* brushes, I noticed, high up on a large tree, a fine clump of *Dendrobium* which I was satisfied must be *D. falcorostrum*. In the neighbourhood of 3,000 feet there was very good "orchid country." *Pterostylis parviflora* reappeared here—a form with flowers as red as those on the plateau, but the plants were taller and less robust. It was rather surprising to find *Orthoceras strictum*, which had been seen during a visit to Bullahdelah a week before under totally different conditions. Near by was a scattered colony of "pigmy" Prasophylls which I could not determine; in general appearance the flowering-spike resembles that of *P. viride*, but the likeness is superficial only. Dr. Rogers was unable to match this plant with any species hitherto published, and a description appears below under the name *P. Hopsonii*. A little further on quite a number of excellent specimens were found of another of these pigmy Prasophylls (Text-fig. 4), which I had discovered twelve months earlier in a tea-tree scrub near Paterson, and which Dr. Rogers has described as *P. Ruppii* (*Trans. Roy. Soc. S. Aust.*, li, 1927). In the middle of this colony was a single plant, with every flower perfect, of *P. fimbriatum*.

To sum up the results of the excursion: Three species were found which are not known at present in any other locality—*Diuris venosa*, *Prasophyllum Rogersii*, and *P. Hopsonii*. The range of habitat has been considerably extended to the north in the case of *Chiloglottis Gunnii*, *Pterostylis falcata*, *P. decurva*, *Thelymitra venosa*, and *Adenochilus*; to which should perhaps be added *Prasophyllum fimbriatum*. Within the limits of four days, evidence was secured of the existence in this locality of 23 species of terrestrial orchids. (Long-withered specimens of a second *Diuris*, not mentioned above, are included in this total.) I think it is probable that a visit in November or early December would be rewarded by the discovery of other species which were not flowering in January, though the late Mr. Hopson considered that the latter month is the time to see the Barrington Tops flora at its best.

Descriptions of Two New Species of Prasophyllum.

PRASOPHYLLUM ROGERSII, n. sp.

Planta gracilis, 30-45 cm. alta. Folium erectum, non inflorescentiam excedens. Spica laxa cum 12-20 floribus subsessilibus. Flores virides, vix tandem odorati. Sepalum dorsale fere erectum, latum, ovatum, acutum, 5·5 mm. longum, 5-nervium. Sepala lateralia separata, lanceolata, 5·5 mm. longa, 3-nervia. Petala erecta, obtusa, lata, 5-5·5 mm. longa. Labellum ovatum marginibus integris, basi fere erectum, in

parte tertia ad apicem flexum: pars callosa prominens et lata, supra flexum extendens. Columna brevis, laciniis parvis. Anthera altior laciniis, humilior rostello.

Plant comparatively slender, 30-45 cm. high, with the leaf-sheath produced into a lamina apparently not exceeding the inflorescence. Flowers 12-20 in a loose spike, almost sessile, greenish, faintly perfumed. Dorsal sepal nearly straight, broadly ovate, acute, 5·5 mm. long, with three prominent nerves and a finer one on each side. Lateral sepals free, spreading, lanceolate, equal to or somewhat longer than the dorsal one, hardly acute, 3-nerved. Petals erect, obtuse, nearly or quite as long as the dorsal sepal, broader than the lateral sepals. Labellum straight for two-thirds of its length from the base; the anterior third merely curved, not sharply reflexed; the whole labellum somewhat broadly ovate, but contracted towards the apex, margins entire; greatest width about 2·75 mm. Callus portion prominent, especially where it extends just beyond the curve, broader towards the base. Column short, the lateral appendages small. Anther broad, higher than the lateral appendages, scarcely as high as the rostellum.

In examining this and the following species for purposes of description, I am indebted to Dr. R. S. Rogers, who sent me the notes he had made on specimens forwarded to him. These made the task of checking my own original notes with moistened herbarium material much less difficult. The character of the labellum of the present species at once marks it as very distinct, and I have ventured to name it after our recognized leader in the field of Australian orchidology. It was growing along a marshy depression on a hillside at a little over 5,000 feet, and about a dozen plants were collected.

PRASOPHYLLUM HOPSONII, n. sp.

Planta gracillima, 10-25 cm. alta, cum bractea sub inflorescentia. Flores 4-12, minutissimi, virides, labellis fuscis. Sepalum dorsale 2 mm. longum, ovatum, cucullatum, saepe apice glanduloso. Sepala lateralia 2-2·5 mm. longa, separata, basi gibbosa, supra aliquantum concava, apicibus glandulosis. Petala erecta, brevissima, fere triangula, acuta. Labellum unguiculatum, ovatum, supra convexum cum notatione fusco in medio, mucronatum apice recurvo. Margines depressi, breviter ciliati. Columna brevis et lata, laciniis bifidis altioribus rostello; chele anterior breviter ciliata, longior et angustior posteriore. Anthera erecta, lata, altior rostello. Ovarium magnum, longius flore.

A very slender plant, 10-25 cm. high, with a sheathing leafy bract just under the flowering spike. Flowers 4-12, minute, greenish, the labellum darker than the other segments. Dorsal sepal broadly ovate, rather strikingly cucullate, acute, often with an obscure gland at the tip. Lateral sepals quite free, gibbous at the base, somewhat concave on the inside, slightly longer than the dorsal sepal, prominently gland-tipped. Petals erect, acute, almost triangular, very short (about 1·5 mm.). Labellum on a movable curved claw, ovate, convex above with a dark median line not well defined, mucronate with a sharply recurved apex. Margins depressed, very shortly and irregularly ciliate. Column short and broad, with bifid lateral appendages higher than the rostellum; anterior segment slightly ciliate, longer and narrower than the blunt posterior segment. Anther erect and broad but acute, higher than the rostellum. Ovary rather large, longer than the flower.

Dr. R. S. Rogers (*Trans. Roy. Soc. S. Australia*, li, 1927, p. 294) has tabulated the published species of *Prasophyllum* which possess ciliated floral segments. The

new species would occupy a place in this table near *P. intricatum* Stuart; but while it agrees with the latter in the incidence of ciliation (labellum and column-appendages), the cilia are developed far more vigorously in *P. intricatum*, and there is little resemblance between the two otherwise. I have named the present species after the late Mr. John Hopson of Eccleston, N.S.W., who located several specimens for me, and to whom I was much indebted for assistance in collecting other orchids of the district.

A List of the Terrestrial Orchids Recorded in this Paper, with References to Illustrations.

Dipodium punctatum R. Br. (Fitzgerald, I, 7).
Gastrodia sesamoides R. Br. (Fitzg., II, 5).
Thelymitra ixioides Swz. (Fitz., II, 3; Hook., *Fl. Tas.*, II).
venosa R. Br.
Diuris venosa Rupp. (Proc. Linn. Soc. N.S.W., li, 3, 1926, and this paper).
sp. ? (withered).
Orthoceras strictum R. Br. (Fitzg., I, 3).
Prasophyllum odoratum Rogers (Rogers, "South Australian Orchids", Plate 6).
brevilabre Hook., f. (Fitzg., II, 1).
fimbriatum R. Br. (Fitzg., I, 5).
Hopsonii Rupp.
Rogersii Rupp.
Ruppii Rogers (this paper).
Microtis parviflora, R. Br. (Fitzg., II, 1).
Corysanthes (leaves only).
Pterostylis falcata Rogers (*Proc. Roy. Soc. Vict.*, 28 (N.S.), I, 1915).
coccinea Fitzg. (Fitzg., I, 4).
decurva Rogers (*Trans. Roy. Soc. S. Aust.*, xlvii, 1923, and this paper).
parviflora R. Br. (Fitzg. I, 7).
cycnocephala Fitzg. (Fitzg., I, 2).
Adenochilus Nortonii Fitzg. (Fitzg., I, 2, and this paper).
Chiloglottis Gunnii Lindl. (Fitzg., II, 2; Rodway, *Fl. Tas.*, p. 208).
reflexa (Cheel). (Fitzg. and Rodway, *loc. cit.*, as *C. diphylla* R. Br.).

References thus (Fitzg., II, 5) are to R. D. Fitzgerald, Australian Orchids, Sydney, 1882. 2 vols.

NOTES ON AUSTRALIAN DIPTERA, No. xvi.

By J. R. Malloch.
(*Communicated by I. M. Mackerras.*)

(Four Text-figures.)

[Read 25th July, 1928.]

Family **Ortalidae.**

Subfamily Platystominae.

Genus Euprosopia Macquart.

This genus occurs from China southward through the Orient to Australia, many of the species occurring in New Guinea, and five being recorded from Australia. Of the latter, *australis* (Walker) is unknown except from the original description, but even if it is a valid species the name is preoccupied by *australis* Macquart, which latter is a synonym of *maculipennis* Guérin.

A peculiar character of the genus is the haired basal section of radius. This vein is very frequently setulose in Ortalidae, but the setulae are almost always confined to that section of the vein beyond level of the humeral cross-vein. Another very striking feature of certain species of the genus is the forward extension of the tegula, which normally is but a small scale covering the root of the wing, and at first I was tempted to consider the species in which the tegulae are carried forward to the humeri as entitled to at least subgeneric distinction, an opinion which I subsequently abandoned on the discovery of the male with normal tegulae and on examining all the species available to me here.

Nothing is known of the economic status of the species of the genus, but amongst the material before me are two species which bear ms. labels 'ex corn' and 'ex scrub' respectively, though without further indication of what the 'ex' means.

I have included in the subjoined key all the species available to me which are likely to occur in Australia or which are new. It is extremely probable that there are many more species to be discovered in Australia.

Unfortunately most of the material before me belongs to the United States National Museum and some types must be deposited in that institution, so that they will not be available even on loan to Australian students of the family.

Key to the Species.

1. Scutellum with a quite pronounced linear depression in centre of apex, and on each side of it glossy black and pronouncedly convex 2
   Scutellum without a distinct central depression at apex and lacking glossy black lateral areas 3
2. Hind margin of second abdominal tergite with pale lanceolate scales; apical dark spot on wing not connected with the preapical dark fascia, a dark streak on costa between the stigmatal fascia and the one over outer cross-vein .. *separata* Hendel

Hind margins of second and third tergites, middle of third, and all of fourth and fifth, with pale lanceolate scales; apical dark spot on wing connected with preapical fascia on costa, no dark streak on costa between the stigmatal fascia and the one over outer cross-vein ..... *conjuncta* Hendel

3. Entire fore legs and all of mid and hind tarsi black; scutellum with a very slight central depression at apex and two short bristles on each side of it; third and fourth abdominal tergites of female and third to fifth in male with sparse pear-shaped pale scales on entire surface; third antennal segment not longer than distance from its apex to mouth margin; central facial area finely transversely furrowed; arista with short hairs at base; tegulae carried forward to the humeri in female, almost normal in male ..... *macrotegularia*, n. sp.

Some part of fore legs yellow or white; scutellum without any indication of a central apical depression and with four or six quite long bristles; abdomen of female without scales, the hairs normal; tegulae not carried beyond middle of mesopleura, usually normal 4

4. Scutellum with four bristles; third antennal segment at least 1·5 times as long as distance from its apex to mouth margin; wings brown, with numerous small pale spots, arranged along, and touching, the veins in the narrow cells; pleura blackish-grey, with three golden-brown dusted vittae, one on upper margin, one below middle of mesopleura, and another on upper half of sternopleura; centre of face yellow; tegulae normal ..... *miliaria* Hendel

Scutellum with six bristles; wings pale, with dark markings, and usually more or less distinctly fasciate (ex. *maculipennis*) 5

5. Arista bare 6

Arista distinctly haired at base, the hairs longer than its basal diameter 7

6. Wing with a blackish fascia extending from stigma over inner cross-vein to middle of second posterior cell, widest on costa, an almost uniformly wide complete fuscous fascia from before apex of second vein which encloses outer cross-vein, a dark spot on wing tip from apex of second vein to apex of fourth, a small streak at anterior extremity of same, and one on costa between the fasciae, and some spots and streaks on basal half of wing; head as high as broad; antennae short, third segment about three times as long as wide; metatarsus of fore legs of male with two compressed, pointed, outwardly bent, bristles at apex .... *tenuicornis* Macquart

Wing with small, rather faint, dark spots, the most conspicuous being a sub-quadrate black mark at stigma which extends to, or slightly over, second vein, no fasciae beyond this; antennae distinctly more than half the length of face; male without a pair of apical bristles on fore metatarsus .. *maculipennis* Guérin

7. Face yellow, with numerous dark dots on the central flat area; tegulae normal; head not much higher than wide; third antennal segment about twice as long as distance from its apex to mouth margin ..... *punctifacies*, n. sp.

Face yellow, without dark dots on central flat area; tegulae produced forward, finger-like, to almost above middle of mesopleura; head about twice as high as wide; third antennal segment about as long as distance from its apex to mouth margin ..... *tegularia*, n. sp.

Euprosopia separata, Hendel.

Head clay-yellow, white dusted along sides of eyes, the centre of frons broadly brown or fuscous, its entire width dark posteriorly, except a patch of grey dust on each orbit; antennal foveae and a streak from each to mouth margin fuscous; sides of labrum and centre of palpi black; antennae orange-yellow. Thorax brown, densely grey dusted, with seven rather faint brown dorsal vittae, the central one evident only in front and behind; scutellum with the lateral convexities glossy black; most of the pleural hairs and bristles white. Abdomen coloured as thorax, paler at base, the tergites brown at apices. Legs reddish-brown, nearly all of tibiae, apices of mid pair faintly, and of hind pair distinctly, blackened, all tarsi black, the basal segment white except at extreme apex. Wings with some short transverse black streaks in cells of basal third, a wedge-shaped fuscous fascia extending from stigma over inner cross-vein almost to hind margin, which encloses several yellowish patches on and near costa, a small dark streak beyond

this on costa, a complete and almost uniform dark fascia from before apex of second vein over outer cross-vein which has pale enclosed patches at costal end, an incomplete dark fascia at apex of second vein, and an isolated dark apical spot extending from before third vein to beyond fourth. Calyptrae white, margin of upper one fuscous, outer half of lower one brownish.

Head higher than long; arista bare; third antennal segment more than three times as long as wide, and fully 1·5 times as long as distance from its apex to mouth margin. Bristles on hind margin of mesopleura slightly lanceolate; scutellum with four bristles. Fore femur without well developed ventral bristles.

Length, 8-9 mm.

Cairns, N. Queensland (A. P. Dodd). Labelled 'ex corn'.

Euprosopia conjuncta Hendel.

I have not seen this species which, however, ought to be readily distinguished from the preceding one by the characters listed in the key, which are culled from the original description.

Both this and the preceding species were described from Townsville, N. Queensland, and *conjuncta* was also recorded from Port Darwin.

Euprosopia macrotegularia, n. sp.

Female.—Head clay-yellow, frons fulvous yellow, narrowly fuscous in centre of anterior half, entirely fuscous posteriorly, and with the posterior orbits broadly, and remainder of orbits narrowly, grey dusted; face with a black streak emanating from each antennal fovea and extending to, or almost to, mouth margin; labrum black except in centre; antennae orange-yellow, third segment browned except at base; arista fuscous, pale at base; palpi black, yellow at bases, and whitish dusted at apices. Thorax brown, with grey dust, mesonotum with three fuscous presutural vittae which are fused except in front, and three complete and four intermediate partial vittae behind suture, some of which are brown instead of fuscous; scutellum concolorous with mesonotum, with three brown vittae; pleura grey dusted in part, and without evident vittae. Abdomen largely dark brown or fuscous above, sides of second tergite, two spots in centre of posterior margin of third tergite, and two on anterior and other two on posterior margin of fourth tergite, grey dusted, fifth tergite with pale pile centrally in front and scale-like pale ornamentation laterally. Legs black, mid and hind tibiae, except their apices, brownish-yellow. Wings hyaline, with fuscous markings as in Text-fig. 1; tegulae greyish testaceous. Calyptrae white, margin of upper one fuscous, disc of the lower one pale brown. Halteres yellow.

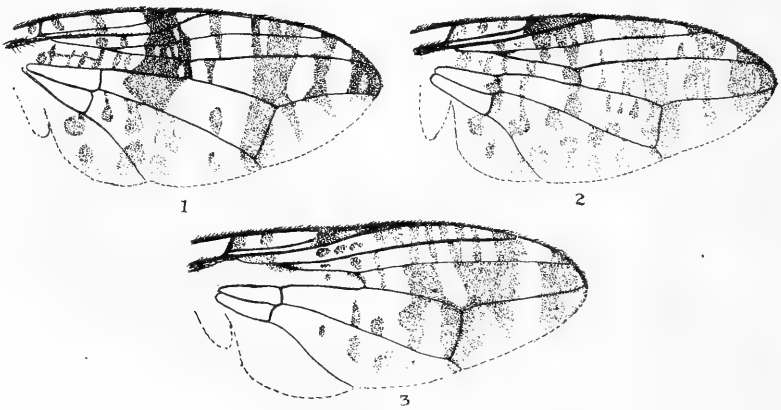
Head about 1·25 times as high as wide; frons depressed in centre; only the outer vertical bristles present, short and stout; ocellars lacking; antennae short, third segment not more than 2·5 times as long as wide, and shorter than distance from its apex to mouth margin; arista short haired at base; flat central portion of face finely transversely furrowed; palpi slightly widened, lanceolate. Dorsal bristles on thorax short, neither humeral nor notopleural bristles present owing to the great development of the closely adherent tegulae; suprasquamal ridge without trace of the long pale hairs so prominent in *separata*; scutellum with a slight central apical depression, and on each side of it two short rather closely placed bristles; mesopleura black-haired on disc, the series of hairs on hind margin white, those on upper portion of series slightly thickened.

Abdomen with pale sparse pear-shaped scales on third and fourth tergites, all hairs on second tergite fine, the fifth tergite with a granulose appearance on sides. Tarsi of fore legs thicker than those of other pairs; fore femur without ventral bristles. Venation of wing as in Text-fig. 1; tegulae elongate, shaped somewhat like the seed of some grasses, extending to humeri and adhering closely to notopleural suture, slightly scaled anteriorly, and with a tridentate scale below at apex in type (sometimes lacking).

Male.—Differs from female as noted in the key.

Length, 8 mm.

Type, Kuranda, Queensland (F. P. Dodd); allotype and 3 paratypes, Cairns, N. Queensland.



Text-fig. 1. *Euprosopia macrotegularia.* Wing.
Text-fig. 2. *E. punctifacies.* Wing.
Text-fig. 3. *E. tegularia.* Wing.

EUPROSOPIA MILIARIA Hendel.

This species is smaller and much duller coloured than *macrotegularia*, and has the wings dull brownish, with many small, paler, hyaline dots.

Hendel describes this species as new under the above name, but lists under it *Platystoma pectorale* Walker, with the name *Euprosopia diminutiva* Walker (of de Meijere) as a synonym.

Why the species name *pectorale* is not used by Hendel I do not know.

The records are from the New Guinea region and Molucca. The single specimen before me is from Arawe, New Britain (Dr. Heydon).

EUPROSOPIA MACULIPENNIS Guérin.

This species was described as *Platystoma australe* by Macquart, and thus, if *Platystoma australe* Walker is a distinct species of *Euprosopia*, it will have to be renamed.

I have not seen *maculipennis*, but it has been recorded from Australia and Tasmania. The characters cited in the key ought to suffice for its recognition.

EUPROSOPIA PUNCTIFACIES, n. sp.

Male.—Head testaceous, upper orbits, triangle, and vertex grey dusted; the frons slightly browned in part above; face with numerous small black dots on

the raised central portion; third antennal segment reddish, becoming brownish above; palpi testaceous yellow; cephalic hairs pale, bristles black. Thorax fuscous, quite densely grey dusted, dorsum with traces of seven dark vittae, none of them complete, the submedian pair distinct only for a short distance behind suture; pleura grey dusted, with a faint brown mark on mesopleura; hairs on thorax mixed pale and dark, the bristles black. Abdomen coloured as thorax, with a brown spot on each side of the median line on tergites 3 to 5, and a transverse brown streak near hind margin of tergites 2 to 4, which is more or less interrupted, and usually connected with the submedian spots on tergites 3 and 4. Legs brownish testaceous, femora darker, especially at apices, the apices of tibiae fuscous, basal segment of all tarsi white, its extreme tip and all of segments 2 to 5 black. Wings with dark brown markings as in Text-fig. 2. Calyptrae white, margin of upper one fuscous. Halteres yellow.

Head almost as wide as high; frons slightly depressed, ocellars microscopic; verticals all strong; postverticals lacking; third antennal segment about twice as long as its distance from mouth margin; arista short haired at base; face not furrowed; bristle on lower occiput long and strong. Humeral and both notopleural bristles present, four bristles on hind margin of mesonotum, and six on scutellum; hairs on hind margin of mesopleura not lanceolate. Abdomen without scales. Fourth wing-vein slightly curved forward at apex. Posteroventral bristles on fore femora well developed and quite numerous.

Length, 8 mm.

Type, Magnetic Is., Queensland (F. P. Dodd ?).

There is no collector's name on the label, but it is similar in appearance to those belonging to the collector suggested above.

EUPROSOPIA TEGULARIA, n. sp.

Female.—Head reddish testaceous, with a brownish streak from each antennal fovea to mouth margin; frontal and facial orbits grey dusted; third antennal segment brownish above; palpi rufous yellow; hairs pale, bristles black. Thorax fuscous, with dense yellowish-grey dust; mesonotum with three rather broad, conspicuous black vittae which are continued over the scutellum; hairs mixed black and yellow, bristles black. Abdomen coloured as thorax, with a broad black vitta on each side of dorsum. Legs rufous, coxae fuscous, tarsi black, basal segment of mid and hind tarsi broadly, of fore pair narrowly, reddish at base. Wings marked with fuscous as in Text-fig. 3. Calyptrae brown, margin of upper one fuscous. Halteres yellow.

Head nearly twice as high as wide; frons at vertex not twice as wide as third antennal segment, gradually widened to anterior margin where it is fully twice as wide as at vertex and fully one-third as wide as its length; vertex with one pair of bristles; postverticals minute; ocellars lacking; third antennal segment more than three times as long as wide and about equal in length to distance from its apex to mouth margin; arista short-haired at base; face not transversely furrowed in centre; cheek about as high as length of third antennal segment. Thorax with the posterior notopleural bristle on a prominent elevation; both notopleurals and humeral bristle present; scutellum with six bristles; suprasquamal ridge long-haired (almost bare in *miliaria*, *punctifacies* and *macrotegularia*). Abdomen without scales. Fore femora without well developed posteroventral bristles.

Length, 11-13 mm.

Type, Solomon Is., July-Aug., 1909 (W. W. Froggatt). One paratype with ms. label apparently 'Alu' or 'Ala'.

The very distinctly vittate thoracic dorsum must be very similar to that of *tigrina* Osten-Sacken, but the pleura in *tigrina* bear two golden vittae which are not present at all in *tegularia*. Possibly the tegulae in the male are normal.

Genus Lamprogaster Macquart.

This genus has many characters in common with *Euprosopia*, but differs in having the radius bare basad of the level of humeral cross-vein. I have not sufficient material to permit me to arrive at a conclusion as to the other characters that can be used for the distinction of the two genera. Hendel cites in his generic key only the fact that the species of *Lamprogaster* have the abdomen metallic, at least in part, and those of *Euprosopia* have it never metallic. It may be that the presence of a strong bristle on the upper hind margin of mesopleura in *Lamprogaster* and its absence in *Euprosopia* is a constant character, as indicated by my species, but I cannot say definitely without access to more material.

There are more than 20 valid species of the genus, many of them Australian.

I have before me several Australian species of the genus, and below I give a short synopsis of the available species to enable students of the group to identify them. I use different characters for my major grouping from those used by Hendel, as I always prefer to make use of structural rather than colour characters in such cases.

Key to species known to the author.

1. Scutellum with many hairs on disc in addition to the marginal bristles 2
   Scutellum without hairs on disc, only the marginal bristles present 5
2. Wings with a conspicuous broad dark brown costal vitta, and the outer cross-vein conspicuously clouded with brown ..... *stenoparia* Hendel
   Wings either entirely yellowish hyaline or with quite faint brownish marks on costal region 3
3. Face with a broad fuscous streak from each antennal fovea to mouth margin; labrum with a fuscous mark on each side; wings yellowish hyaline, without dark markings ..... *xanthoptera* Hendel
   Face and labrum yellow 4
4. Wings entirely yellowish hyaline, without any indication of brown markings; hairs and bristles entirely luteous ..... *zelotypa* Hendel
   Wings more intensely yellow along costal half, and with indications of a brownish streak from costa to inner cross-vein, a small pale brown spot near apex of second vein, and a darker brown cloud along tip of costa; hairs and bristles of dorsum black ..... *indistincta*, n. sp.
5. Wing with a conspicuous zig-zag black mark extending from humeral cross-vein across disc to apices of posterior basal cells, and in addition three other black marks along costa, the largest extending over inner cross-vein, a smaller spot near apex of second vein, and a narrow streak round apex of costa; thorax metallic blue-green in centre of disc, the sides and pleura fulvous yellow .... *bicolor* Macquart
   No conspicuous black mark basad of the one on costa which extends to inner cross-vein 6
6. Thorax fulvous yellow, with a broad metallic blue-green stripe on dorsum, on which are three grey-dusted vittae; the dark mark on costa at level of inner cross-vein large and subquadrate, deep black; outer cross-vein not clouded ..... *flavipennis* Macquart
   Thoracic dorsum entirely metallic blue-green, without noticeable grey dusted vittae; the dark mark on costa at level of inner cross-vein narrow, usually pale brown except on inner portion, where it becomes black; outer cross-vein quite noticeably clouded ..... *lepida* Walker

LAMPROGASTER XANTHOPTERA Hendel.

This species is dark blue-green, with a strong violet tinge on dorsum of abdomen, and the legs are entirely yellow except for the dark tips of tarsi. In addition to the dark marks on head mentioned in the key the cheeks are brownish.

Originally described from New Britain; I have before me a specimen from the Solomon Islands, collected in 1909 by W. W. Froggatt and sent by him to the United States National Museum.

LAMPROGASTER BICOLOR Macquart.

This species is one of a group which has the costal margin of the wings marked more or less distinctly with black or brown spots, the greatest number being four, as in the present species. One might be pardoned for doubting the claim of the various forms to more than varietal rank, but I believe, from an examination of the material in hand now, that the differently marked forms are really valid species, offshoots of one parent species. The species are very similar and it may be that the names given by Hendel are not correctly applied, but only an examination of the types, if these are in existence, will determine this. It appears possible that *laeta* Macquart might be the same as the species now before me.

Locality.—Mt. Kosciusko, N.S.W., 1893.

LAMPROGASTER FLAVIPENNIS Macquart.

I have but one specimen which I refer here before me. The large black mark at level of inner cross-vein is very conspicuous, the apical dark mark is less evident, and the small dark spot on second vein is quite inconspicuous. The legs are almost entirely black in the male before me, but there is evidently some variation in this character in this species, as there is a variety named *nigripes*.

Locality.—Gisborne, V. (Lyell).

LAMPROGASTER LEPIDA Walker.

Readily distinguished from the preceding two species by the uniform metallic blue-green dorsum of thorax and abdomen, and also by the less intense black colour of the spot on costa at level of inner cross-vein; the apical costal mark is usually darker than the other markings.

Localities.—Hamilton and Gordonvale, Queensland.

LAMPROGASTER INDISTINCTA, n. sp.

Male.—Head fulvous yellow, frons and cheeks brownish-red, orbits and lower occiput yellow dusted, antennae and palpi orange-yellow. Thorax fulvous yellow, centre of mesonotum broadly metallic blue-green, the dark colour not sharply margined laterally, and without grey vittae; scutellum without metallic lustre; hairs on mesonotum and all bristles black. Abdomen glossy brownish testaceous, with but slight metallic tinge, hairs mostly dark. Legs fulvous yellow, apices of tarsi fuscous. Wings yellow hyaline, with four faint rudimentary brownish marks situated as in *bicolor*, the apical costal one most evident. Calyptrae yellow.

Arista pubescent at base; head as in *bicolor*. Scutellum with a slight apical central depression, and eight marginal bristles. Outer cross-vein of wing sloping towards base of wing at its anterior extremity; veins 3 and 4 very slightly incurved at extreme apices.

Length, 10 mm.

Type, Banks Island, N. Australia (W. W. Froggatt).

Type specimen in United States National Museum.

LAMPROGASTER ZELOTYPA Hendel.

This is one of the few species of the genus in which the wings are without dark markings. The entire head, thorax, and abdomen are yellow in the male before me, the last having but a slight indication of a violet tinge on dorsum, though it is glossy. The hairs and bristles are yellow, and the strong bristle on upper hind margin of the mesopleura is hard to distinguish from the hairs on this account.

I have before me one specimen from Cairns, N. Queensland.

Hendel cites *L. ventralis* Walker as the same species, and lists it from New Guinea and Australia.

LAMPROGASTER STENOPARIA Hendel.

This species has the general colour of thorax and abdomen bright metallic blue, the abdomen more amethyst, the wings with a broad costal cloud of dark brown, and the outer cross-vein with a brown cloud. The legs are yellow, with the apices of the tarsi brownish. The mesopleural bristle is black and prominent.

The specimen before me is from Cairns, N. Queensland (A. P. Dodd).

Known only from Queensland.

Genus DUOMYIA Walker.

This genus was placed in the Stenopterini by Hendel, but my opinion is that it belongs to the Platystomini, the cephalic characters being very similar to those of *Lamprogaster* and *Euprosopia*. In fact, when one considers the head structure, large lower squama, and thoracic characters, no other conclusion remains but that its affinities (or at least those of the genotype) are with the two genera above named.

I have before me the genotype of *Duomyia* and cite as the distinguishing characters of the genus only those possessed by that species. It may be that at least some of the species included in *Duomyia* by authors do not agree with these characters in all respects. One Australian species before me does not.

Hendel, in distinguishing the tribes of Platystominae, selects the habitus of the insects as criteria almost exclusively, separating those with ant-like structure from the others, and further subdividing the remainder into groups of slender bodied and plump species after removing Trapherini on the structure of the epistome. The system is not an unqualified success, as can be seen from the inclusion in the slender bodied group Stenopterini, of the genus *Duomyia*, the genotype, *obscura* Walker, being one of the most robust species available to me at this time.

The material at my disposal, however, is insufficient to permit of an exhaustive survey of even the Australian species, so I merely deal with some of the more outstanding forms in this paper.

The genus *Duomyia*, as represented by the genotype, is readily distinguished from *Euprosopia* by the lack of hairs on the radius basad of the humeral cross-vein, and by the presence of fine hairs on hind coxae above bases of the femora. From *Lamprogaster* it is distinguished by the last-mentioned character, and the lack of a bristle on the upper portion of the hind margin of the mesopleura.

Of the 13 species placed in the genus by Hendel, 12 occur in Australia, and 1 in Chile. The last-mentioned species may not be congeneric with the Australian forms.

DUOMYIA OBSCURA Walker.

A synonym of this is *Stenopterina gigas* Macquart.

Two males, Brisbane; one female, Banks Island.

Genus ACHIAS Fabricius.

The species of this genus have the head widened, generally more so in the males than in the females, usually distinctly wider than the thorax, and in some cases with the eyes on prominent processes or stalks, much as in the family Diopsidae. In addition to this character, the arista is long haired on almost the entire length, the central plate of face has a sharp edge along inner margin of each antennal fovea and there is no bristle on the upper portion of hind margin of mesopleura.

Hendel records no species of the genus from Australia, but I have seen two from Kuranda, Queensland. There are about 16 described species, many of them from New Guinea. I am not certain of the identity of the two Australian species at present.

Subfamily RIVELLIINAE.

This subfamily is readily distinguished from the genera above dealt with by the very much smaller lower calypter. I may have an opportunity to go into more detailed definition of these groups at some future time if more material is available. Most of the specimens of the family collected by the late Dr. E. W. Ferguson were sent to Dr. Bezzi before the death of the latter and, unless that material is returned so that it can be used for a survey of the family, fresh specimens will have to be obtained from other sources.

Genus RIVELLIA Robineau-Desvoidy.

I have two species of this genus before me from Australia. Only one of them I have been able to identify as already described.

RIVELLIA CONNATA (Thomson).

Localities.—Coramba, Dorrigo Rd., 1,000 feet, 31.1.22; and Belaringar, 9.9.23, N.S.W.; Tammin, and Merredin, W.A., 1926 (E. W. Ferguson).

Genus ELASSOGASTER Bigot.

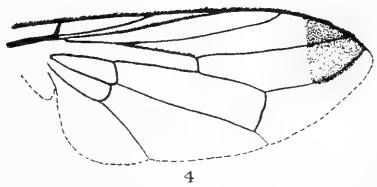
This genus is placed in Stenopterini by Hendel. The only distinguishing character which he cites for the group that applies to this genus is the shape of the abdomen. This is rather elongate, more or less compressed from the sides, and about uniformly wide from base to apex. The Rivelliini have the abdomen more ovate, and the Platystomini have it broad at base and tapered to apex. I hardly dare to suggest the use of such a character to anyone who does not have first a strong intuitive inclination to put the insects into their proper segregates, and incline to disregard the grouping.

I have not seen the genotype of *Elassogaster*, which is *metallicus* Bigot. Three or four of the 16 known species of the genus occur in New Guinea, and several in Africa. The records below are the first from Australia.

ELASSOGASTER SEPSOIDES Walker.

A metallic blue-green species. Antennae reddish-yellow; palpi black; frons dark brown; vibrissal angles yellowish. Thoracic dorsum somewhat granulose,

with a narrow central vitta of grey dust which is divided into two a little behind suture. Legs rufous yellow, usually with the mid and hind femora browned in part, fore tibiae and tarsi and apices of mid and hind tarsi fuscous, hind tibiae sometimes browned. Wings clear, with a large fuscous spot at apex as in Text-fig. 4.



Text-fig. 4. *Elassogaster sepsoides.* Wing.

Frons with only the four verticals present; arista subnude; face convex centrally, without sharply defined foveae; palpi broad; third antennal segment fully three times as long as wide; labrum broadly exposed. Prosternum broad, hairy; only the bristle near humeral angle present on anterior margin of thorax, the acrostichal pair undeveloped; mesopleura with a strong upper hind marginal bristle; humeral and both notopleural bristles present; scutellum with four marginal bristles and no fine discal hairs. Wing venation as in Text-fig. 4.

Length, 6-8 mm.

Localities.—Hamilton, Queensland, January, 1890; Cairns, N. Queensland, 'dung' (J. F. Illingworth).

A widely distributed species, occurring in Ceylon, Formosa, Amboina, Philippine Islands and New Guinea.

The material which I have examined from the Philippines is the type series of *Plagiostenopterina hendeli* Knab, which is a synonym of *sepsoides.* The specimens are labelled, 'larvae feeding on egg-pods of *Locusta migratoria*'. The larvae may be more or less scavengers as indicated by the record on the specimen collected at Cairns.

Elassogaster terrae-reginae, n. sp.

Male and female.—Similar to *sepsoides* in general colour, but the wing tips are without a dark spot, there being only a faint narrow pale brown suffusion along the apical portion of costa beyond apex of second vein, the legs are honey-yellow, except the fore tibiae and tarsi which are deep black, the dorsocentral white dusted vitta on the mesonotum is a little wider, not divided behind suture, and continued on to base of scutellum.

Structurally the two species are quite similar, but the fourth wing-vein in the new one is but slightly curved forward at apex, ending behind tip of wing and almost directly below apex of third, the disc of scutellum is not bare, but has many pale fine hairs similar to those on mesonotum, and the frons is distinctly broader and quite distinctly punctured.

Length, 6 mm.

Type, male, and allotype, the latter fragmentary, taken *in copula*, Townsville, N. Queensland (G. F. Hill); 4 paratypes, Como, N.S.W. (H. Petersen).

Returned to collector.

This species is closely similar to *albopilosus* de Meijere described from New Guinea, but it has a vertical band of white dust on the pleura which that species lacks. It is also rather similar to *metallicus* Bigot, described from Rodrigues Is., but the tibiae and tarsi of the latter are brown, and the thorax has three bluish vittae, the face is evidently more testaceous, and there are some other colour distinctions.

Genus Plagiostenopterina Hendel.

This genus was distinguished from *Stenopterina*, a New World genus, by the structure of the frons, which is puffed out ('wulstig') in *Stenopterina* and not so in the other, by the lack of an orbital bristle, and the distinctly narrowed first posterior cell of the wing. From *Elassogaster* Bigot it was distinguished by the obliquely placed inner cross-vein of wing, *Elassogaster* having this vein erect.

I have before me the genotypes of the two first-named and find it difficult to appreciate the puffed out frons, while the lack of an orbital bristle does not apply in all species of *Plagiostenopterina*. I find, however, that *Stenopterina brevipes* Fabricius, the genotype, has no strong bristle on the upper hind margin of mesopleura, and has the notopleurals 1 + 2, while all species of *Plagiostenopterina* before me have a strong mesopleural bristle, and the notopleurals 1 + 1.

Plagiostenopterina aenea (Wiedemann).

The genotype. A metallic bluish or greenish black species, with hyaline wings, the latter marked with two narrow fuscous vittae, one extending along costa from apex of auxiliary vein to apex of fourth, the other extending from base of wing to, or almost to, outer cross-vein, filling basal cell, and hardly encroaching on discal cell. The scutellum has four marginal bristles and many fine discal hairs. Arista short haired on basal third or more.

Length, 8-11 mm.

Locality.—Cairns, N. Queensland (J. F. Illingworth). Hendel records it from Townsville, Queensland.

The same author places *Dacus basalis* Walker in *Plagiostenopterina*. It was described from Port Essington, N. Australia. I have not seen the species.

Family Ephydridae.

Genus Brachydeutera Loew.

In a previous part of this series of papers I presented the description of an Australian species of this genus, and below I describe a second one. All three species known to me are very similar in structure, the specific distinctions consisting of slight differences in chaetotaxy, venation of the wings, and colour.

The two Australian species may be distinguished as below.

A. Anterior notopleural bristle lacking; abdomen hardly shining, with dense grey dust on dorsum, most of the tergites with dark brown basal and apical fasciae, broadest on second tergite, and connected by a dark streak in centre on fourth, and sometimes on fifth; upper portion of mesopleura with yellowish or brownish dust showing on the grey ..... *sydneyensis* Malloch

AA. Anterior notopleural bristle present, not as long as posterior one; abdomen olivaceous black, slightly shining, with grey dust on lateral angles of dorsal exposure of tergites, and on most of apical tergite; entire pleura densely whitish grey dusted ..... *pleuralis*, n. sp.

BRACHYDEUTERA PLEURALIS, n. sp.

Male and female.—Head brownish-black; frons dull; occiput brownish dusted above, lower half, cheeks, and face whitish-grey dusted, centre of latter darker; antennae black; palpi white. Thorax olivaceous black on dorsum, and with traces of three or five brown vittae, the humeral angles, and to a lesser extent the lateral margins of mesonotum, whitish-grey dusted; pleura entirely covered with dense whitish-grey dust; scutellum slightly grey dusted at base. Abdomen olivaceous black on dorsum, whitish-grey dusted on the incurved lateral parts of tergites, the pale parts showing slightly at anterior and posterior angles of tergites from above. Legs clay-yellow, coxae densely whitish-grey dusted, apices of mid and hind femora faintly brownish on upper surface, tarsi fuscous. Wings clear. Calyptrae and halteres white.

Structurally similar to *sydneyensis* but smaller; the anterior notopleural bristle present; second wing-vein slightly curved; outer cross-vein slightly bent, its upper portion sloping slightly towards base of wing, and the fourth vein slightly deflected apically, causing the first posterior cell to be slightly widened at tip.

Length, 2·5 mm.

Type and allotype, Townsville, Queensland (F. H. Taylor).

The label bears the notation 'Larvae live in water', and mounted with each of the specimens is an empty puparium similar to that of the North American species.

Family **Drosophilidae.**

I present below the description of a new species belonging to one of the recently described genera closely related to *Drosophila*. I hope to be able to present an enlarged key to the Australian genera of this family shortly.

Genus LIODROSOPHILA Duda.

This genus is quite similar to *Drosophila* Fallen, but there is no closed anal cell in the wings, the anal vein being short and curved, but the cell is open. In most characters the genera agree quite closely, but in the only species I have seen from Australia and in most of the other species of *Liodrosophila* the thorax or abdomen is at least partly metallic blue or green.

The species described below appears to be distinct from any already known, though rather similar to *metallescens* de Meijere, which occurs in Java, Formosa, and New Guinea.

LIODROSOPHILA AUSTRALIS, n. sp.

Female.—Head fulvous yellow, frons entirely glossy, and with a metallic blue tinge except in front; antennae and palpi concolorous with head. Thorax glossy fulvous yellow, mesonotum gradually becoming more deeply suffused with metallic blue from middle to hind margin; scutellum dull fulvous yellow, paler at apex. Abdomen entirely metallic dark violet-blue above, the sternites yellowish; hairs and bristles black. Legs yellow, Wings clear, with an oblique dark cloud running from alulae forward along first vein to costa. Knobs of halteres dark brown.

Frons at vertex as wide as long in centre; postverticals short; all vertical bristles and the ocellars long and strong; proclinate and posterior reclinate orbital long, anterior reclinate very short; some setulose hairs in a curved series above antennae on each side extending backward to about middle of frons; arista with four rays above and two below; facial keel long, and rather flat above.

Thorax with about eight series of intradorsocentral hairs, two pairs of dorsocentrals, no prescutellar acrostichals, and two long sternopleurals; basal pair of scutellar bristles not half as long as apical pair. Legs normal. Second and third costal divisions of wing subequal; penultimate section of fourth vein about two-thirds as long as ultimate section.

Length, 2 mm.

Type, Mossman, Queensland (F. H. Taylor).

Family Sapromyzidae.

Genus Sapromyza Fallen.

I have already presented descriptions of many species of this genus and given a synoptic key for the identification of most of them. Since the key was published I have had access to more material and the appearance of the descriptions of many new species of the genus in two recent papers has made the key quite inadequate for purposes of identification. I therefore present below a new key, which I hope will serve to identify the 43 already described species, and have a longer period of usefulness than the preceding one. It is of course quite evident to me that there are many still undiscovered species of the genus in Australia, because with almost every lot submitted there are species which I have not previously seen, so that it will be merely a matter of time until this key also is out of date, and the sooner more material is available, especially from localities other than those from which the previous shipments emanated, the sooner this will take place.

I describe one new species in this paper, and also redescribe a species of Macquart's which he placed in *Sciomyza*. This species is redescribed from the type specimen and, unless most of Macquart's other species are available in type material, it will be impossible to place them correctly, as many were described in genera to which they do not belong, and only colour characters were used in his descriptions.

Key to the species.

1. Thorax with four pairs of strong dorsocentrals, the anterior pair in front of suture 2
   Thorax with three pairs of dorsocentrals, the anterior pair slightly, or distinctly, behind suture, and sometimes rather short and weak 12
2. Wings distinctly marked with dark colour, or almost entirely fuscous 3
   Wings yellowish or greyish hyaline, without dark markings 6
3. Fore femur with an anteroventral comb of minute setulae apically; thorax with about five pairs of strong acrostichal bristles; arista long haired 4
   Fore femur without an anteroventral comb; thorax without strong acrostichals except the prescutellar pair, only weak hairs present in two series anteriorly; arista microscopically pubescent 5
4. Wing with a dark brown cloud on costa from apex of auxiliary vein to tip, which becomes paler behind and disappears at or before reaching fourth vein, and does not connect with the two clouds over the cross-veins; thorax densely grey dusted, with six broken brown vittae on dorsum ..... *plumiseta* Malloch
   Wing with a blackish-brown cloud from apex of auxiliary vein to tip, which extends inward over third vein from just beyond the cloud over inner cross-vein, but does not connect with the latter, and fuses with the one on middle of apical section of fourth vein, the second posterior and anal cells with fainter dark clouds; thorax densely grey dusted, with four brown vittae, the submedian pair narrower, fused behind, and carried over disc of scutellum ..... *petersoni* Malloch
5. Wings infuscated at bases, the dark colour extending to a little beyond humeral cross-vein, to furcation of second and third veins, and to apices of the basal

cells; thoracic dorsum grey dusted, with two broad submedian brown vittae which are blackish on their inner margins, and numerous large lateral brown markings ..... *hieroglyphica* Malloch

Wings almost uniformly deep fuscous brown; thorax shining brownish testaceous, not evidently vittate or marked with brown ..... *suffusa* Malloch

6. Only the posterior two pairs of acrostichal bristles long and strong 7

Four or more pairs of the acrostichal bristles long and strong 8

7. Arista with its longest hairs about as long as its basal diameter; fore femur with a distinct anteroventral comb on apical half; third antennal segment narrowed just beyond insertion of arista, slightly tapered to apex; abdomen subopaque, brownish or fuscous; mid femur with a series of stout bristles on apical half of anterior surface; mid tibia with two long apical ventral bristles .... *hirtiventris* Malloch

Arista practically bare; fore femur without an anteroventral comb; third antennal segment hardly longer than wide; abdomen glossy black; mid femur without anterior bristles; mid tibia with only one long strong apical ventral bristle ..... *pilifrons* Malloch

8. Arista ranging from almost bare to distinctly pubescent, the longest hairs not noticeably longer than its basal diameter; fore femur without an anteroventral preapical comb; mid tibia with but one long strong apical ventral bristle 9

Arista with its longest hairs conspicuously longer than its basal diameter, at least as long as half the width of third antennal segment; fore femur with an anteroventral preapical comb; mid tibia with two long strong apical ventral bristles 10

9. Head and thorax fulvous yellow, the former with ocellar spot, a spot below each eye, and one on each side of face, fuscous; abdomen yellow, glossy black on dorsum except at base; legs entirely fulvous yellow; frons entirely shining ..... *tonnoiri* Malloch

Head fulvous yellow, the ocellar spot and labrum fuscous, orbits hardly darkened, antennae bright fulvous; thorax black, with slight greenish tinge, the entire surface densely grey dusted; abdomen black, with conspicuous greenish lustre; legs yellow, fore pair except knees, mid and hind femora at bases, and same tibiae and tarsi at apices black ..... *subaeneiventris* Malloch

10. Arista short haired, the longest hairs not, or but little, longer than half the width of third antennal segment; palpi, third antennal segment, apices of femora, of tibiae, and of mid and hind tarsi, and all, or most, of fore tarsi black; frontal triangle, the lines on which the fronto-orbital bristles are situated, and a line along each lateral part of anterior margin silvery dusted; submedian thoracic vittae uniform ..... *bicoloripes* Malloch

Arista plumose, the longest hairs more than half as long as width of third antennal segment; antennae yellow, third segment at most brownish; legs not sharply bicoloured, either uniformly yellowish, or the femora infuscated except apically 11

11. Femora infuscated except apically; thorax with four narrow brown interrupted vittae on dorsum, and a broader dark brown one on upper part of pleura; abdomen densely opaque grey dusted, a medianly interrupted chocolate-brown fascia on base of each visible tergite from second to fifth, and a brown spot on the incurved lateral part of each tergite from first; the one on fourth connected with basal fascia ..... *variventris* Malloch

Legs unicolorous tawny or testaceous yellow; pleura not vittate, thoracic dorsum very faintly or not at all vittate; abdomen unicolorous, or very faintly marked ..... *spinigera* Malloch

12. Antennae as long as head, third segment more than three times as long as wide, first and second segments subequal in length on outer side, or the first longest, first with a few microscopic hairs below at apex; parafacials white dusted, with a velvety black mark between each antenna and eye; abdomen glossy black .. 13

Antennae much shorter than head, first segment much shorter than second 14

13. Mesopleura with two long strong bristles, which are rather closely placed and above the middle on hind margin; mid tibia with two long apical ventral bristles; thorax without dark dorsal vittae; wings honey-yellow, apices narrowly and faintly brownish; third antennal segment fully three times as long as wide .... *magnicornis* Malloch

Mesopleura with one long strong bristle above middle on hind margin; mid tibia with one short and one long apical bristle; thorax with two submedian vittae, and the lateral margins conspicuously whitish dusted; wings honey-yellow; third antennal segment more than six times as long as wide .... *tenuicornis* Malloch

14. Thoracic dorsum with the anterior one or two pairs of postsutural dorsocentral bristles much weaker than the posterior pair, almost hair-like, the anterior pair almost invariably well behind suture; arista pubescent or almost bare 15

Thoracic dorsum with the three pairs of postsutural dorsocentrals almost equally long and strong, the anterior pair very close to, or at suture; arista variously haired 34

15. Frons and face deep black, the parafacials yellowish or whitish 16

At least the face yellow or brownish-yellow 17

16. Entire frons shining; third antennal segment fully twice as long as wide; knobs of halteres black ..... *sciomyzina* Schiner

Frons opaque velvety black, orbital stripes and ocellar triangle glossy; third antennal segment very little longer than wide; knobs of halteres pale yellow .... *brevicornis* Malloch

17. Entire insect including head and its appendages, and the legs testaceous yellow .. 37

At least some part of the head, body, or legs, black or fuscous 18

18. Pleura, metanotum, and abdomen black, densely grey dusted; dorsum of thorax and the head yellow, upper occiput and ocellar spot fuscous; antennae and palpi black; fore and hind femora and bases of mid pair fuscous .... *flavodorsalis* Malloch

Species not coloured as above 19

19. Frons entirely opaque, the orbital stripes forming two complete grey or dark vittae 20

Frons with at least the orbital stripes shining and undusted 21

20. Frontal orbits densely pale yellowish-grey dusted; wings without dark markings; thoracic dorsum with two conspicuous brown vittae; mesopleura largely fuscous; scutellum reddish-yellow, darker on disc, with a deep black spot at base of each apical bristle, grey dusted between them ..... *riparia* Malloch

Frontal orbits black, forming two velvety vittae; wings conspicuously spotted with fuscous; thoracic dorsum and pleura conspicuously vittate with black; scutellum flattened and black on disc, yellow on sides ..... *magnifica* Malloch

21. Antennae largely or entirely black 22

Antennae entirely yellow 32

22. Femora and tibiae testaceous yellow ..... *immaculipes* Malloch

Femora and tibiae of one or more pairs of legs marked with black 23

23. Frons black 24

Frons tawny yellow, or yellowish-brown 25

24. Frons black, face yellowish-white, occiput tawny yellow; the fore femora blackened beyond basal third ..... *alboatra* Malloch

Frons, centre of face, and occiput black; fore femora entirely black .. *mariae* Malloch

25. Frons yellowish brown; occiput with a large black mark on each side of upper half; all femora largely black ..... *occipitalis* Malloch

Frons tawny yellow; occiput without black marks on upper half 26

26. Wings without dark markings 27

Wings with distinct dark markings 31

27. Face with a black line along sutures between central part and parafacials; abdomen black, yellow at base; humeri with some microscopic fine hairs besides the strong bristle; areas mesad of the humeral angles very sparsely furnished with weak setulae; fore tarsi with a lanceolate bristle at apex of basal segment on posterior side which is about as long as width of the segment ..... *lancifer* Malloch

Face entirely tawny yellow; fore tarsi without abnormal shaped bristles at apex of basal segment on posterior side 28

28. Palpi broadly blackened at apices 29

Palpi yellow 30

29. Fore legs except the coxae and trochanters blackened, mid and hind pairs yellow; pleura entirely yellow ..... *atrimana*, n. sp.

Fore, mid, and hind legs all with the femora narrowly black at apices, and the tibiae more broadly blackened at apices; mesopleura blackened on upper margin, more broadly behind ..... *nigricornis* (Macquart)

30. Humeri exceptionally prominent, bare except for the single strong bristle, the hairs on mesonotum adjacent to humeri much more numerous, shorter, and bristle-like than usual ..... *regalis* Malloch
Humeri not unusually prominent, with a few microscopic fine hairs besides the single strong bristle, the hairs on mesonotum adjacent to humeri neither exceptionally numerous nor stronger than usual ..... *avicola* Malloch
31. Wing with a narrow fuscous cloud extending from base along costa to apex of fourth vein, and another faint brownish cloud over outer cross-vein; thoracic dorsum bivittate with fuscous ..... *fuscocostata* Malloch
Wing with the dark markings confined to a fuscous suffusion of the cell between apices of auxiliary and first veins; thorax not vittate ..... *stigmatica* Malloch
32. Legs with conspicuous black markings; abdomen largely glossy black; arista almost bare 33
Legs and abdomen testaceous yellow; arista long pubescent, the longest hairs fully as long as its basal diameter ..... *parviceps* Malloch
33. Face flat or slightly concave, not at all evident between bases of antennae, and distinctly less shining than the uniformly shining fulvous frons; fore femora blackened except basally; mesopleural hairs weak; fore tarsi yellow, but little darker apically; fifth tergite of male produced downward on anterior margin, and with a slender backwardly directed process on each side which projects on each side of the very large hypopygium ..... *flavimana* Malloch
Face prominently convex vertically, quite prominent between bases of antennae, and very distinctly shining, the frons opaque black except the glossy orbital stripes; fore femora black at apices; mesopleural hairs almost bristle-like; fore tarsi black except the basal segment ..... *mariae* Malloch
34. Arista plumose; a well developed bristle present on thoracic dorsum slightly behind and mesad of the supra-alar bristle; fore femur without an antero-ventral preapical comb of minute setulae 35
Arista very short haired or indistinctly pubescent; no evident bristle on thoracic dorsum behind and mesad of the supra-alar bristle 36
35. Submedian pale brown vittae continued to anterior margin of mesonotum; no conspicuous spots on posterior margin of mesonotum ..... *aberrans* Malloch
Submedian pale brown vittae broken near anterior margin of mesonotum; a pair of black spots on posterior margin of mesonotum which appear velvety in some lights and which extend on to base of scutellum ..... *maculithorax* Malloch
36. Longest hairs on arista distinctly longer than its basal diameter; wings copiously spotted with fuscous, appearing reticulated; face with two dark spots; frons with two brown vittae; mesonotum with four brown vittae; mesopleura with two brown spots; fore femur without a comb; antennae entirely black; mid tibia with two unequal apical ventral bristles ..... *ocellaris* Malloch
Arista very indistinctly pubescent, the hairs not longer than its basal diameter; wings without dark spots, sometimes with clouds along veins 37
37. Entire insect, including the legs, shining testaceous yellow; fore femur with a distinct preapical anteroventral comb of minute black setulae 38
Entire insect not shining testaceous yellow, bicoloured, the legs partly black .. 39
38. Inner cross-vein of wings a little beyond apex of first vein, the penultimate section of fourth vein fully two-thirds as long as ultimate section; legs stout; anterior pair of orbital bristles about twice as long as, and much stouter than, ocellar pair; hairs on entire body strong ..... *unicolorata* Malloch
Inner cross-vein of wing below apex of first vein, the penultimate section of fourth vein not more than half as long as ultimate section; legs slender; anterior pair of orbital bristles not as long as ocellar pair; hairs on body weak ..... *urbana* Malloch
39. Thorax entirely fulvous yellow, conspicuously shining, without evident dusting or vittae; head yellow; antennae almost entirely black; ocellar bristles microscopic ..... *strahani* Malloch
Thorax black or brown, densely dusted, and not vittate, or yellowish, with conspicuous dorsal vittae 40
40. Thoracic dorsum not vittate, densely greyish or brownish dusted 41
Thoracic dorsum conspicuously vittate, densely greyish or brownish dusted 43
41. Thoracic dorsum with a dark dot at base of each hair and bristle ..... *punctiseta* Malloch
Thoracic dorsum without dark dots on dorsum 42

42. Face with a dark vertical central stripe; dorsum of thorax brownish dusted ..... *aureocapitata* Malloch
Face without a dark central stripe; dorsum of thorax grey dusted ..... *griseodorsalis* Malloch

43. Frons rather densely covered with short black setulose hairs anteriorly; face with a vertical line on each side, and frons with a central line, blackish; thoracic dorsum with linear blackish vittae, the lateral pair short and indistinct; costal and second wing-veins, and outer cross-vein, and sometimes also third vein, bordered with fuscous ..... *fuscolimbata* Malloch
Frons practically bare except for the strong bristles; face and frons without fuscous lines as above; thoracic vittae brown, quite broad, and all four entire; veins of wings not bordered with fuscous 44

44. Palpi yellow; fronto-orbital bristles situated on a narrow grey stripe which is separated from the grey margin anteriorly by a narrow stripe of the same golden colour as the interfrontalia; fore femur without an anteroventral comb ..... *victoriae* Malloch
Palpi black; fronto-orbital bristles situated on the wide whitish lateral stripes; fore femur with a weak but evident preapical anteroventral comb ..... *brunneovittata* Malloch

Sapromyza nigricornis (Macquart).

Female.—A testaceous yellow species, with frons dull, the orbital stripes shining, third antennal segment black, second yellow, palpi broadly black at apices, upper margin of mesopleura fuscous, more broadly so posteriorly, thoracic dorsum shining, not vittate; abdomen shining, without black markings. Legs yellow testaceous, apices of femora narrowly, of tibiae more broadly, black, apical three tarsal segments fuscous. Wings yellowish hyaline. Halteres yellow.

Frons a little longer than wide, all the bristles well developed; postocular fringe strong, bristle-like above; antennae normal, third segment slightly tapered apically and about twice as long as wide; arista pubescent; palpi normal. Thorax with three pairs of postsutural dorsocentrals, the anterior pair not very much reduced, but farther from suture than from next pair; humeral angles haired, the hairs on mesonotum adjacent to the humeri setulose. Mid tibia with two long and one short apical ventral bristles. Inner cross-vein below apex of first vein and a little beyond middle of discal cell.

Length, 7·5 mm.

This species is redescribed from the type specimen sent by M. E. Seguy to Dr. A. L. Tonnoir at his request, and sent by the latter to me. The specimen is in good condition, except that it is entirely overlaid with a fine web such as the spinning mites make. There is no locality on the label, but Macquart cited Tasmania and Akaroa in his paper. I suspect that it belongs to Tasmania only. I have placed the species in my key amongst those with the anterior postsutural dorsocentral bristle much reduced and far from suture, but if one decides to place it amongst those which have the anterior bristle little reduced and rather close to suture it will run down to *strahani* Malloch, from which species it may readily be distinguished by the less extensively blackened legs, and the long and strong ocellar bristles.

Sapromyza atrimana, n. sp.

Male.—Quite similar to *nigricornis* in colour and structure, but the fore legs are fuscous from near base of femora to tips of tarsi, the mid and hind legs are yellow, the pleura yellow, the ocellar bristles are microscopic, the entire antennae are dark brown, the anterior pair of postsutural dorsocentral bristles

is quite small, and there is one long and one short apical ventral bristle on mid tibia.

Length, 6 mm.

Type, Perth, W.A., Nov. 15, 1926 (Nicholson).

In connection with the preceding species it may be well to indicate that Hendel lists a species under *Sapromyza* as *nigricornis* Robineau-Desvoidy. This was described as a species of *Lycia* and without access to the type specimen it would appear to me impossible to determine if it belongs to the genus *Sapromyza*. It has not been identified since its original description.

Family **Calliphoridae.**

Genus ANTHRACOMYIA Malloch.

This genus was erected in my recent paper on Australian Calliphoridae, but the name is preoccupied by *Anthracomyia* Rondani. I therefore propose to supplant it with *Anthracomyza*, n.n. I recently referred to this genus under the latter name in a paper on Calliphoridae of Sumatra.

Family **Stratiomyiidae.**

Heretofore I have dealt almost exclusively with families in the Cyclorrhapha, but amongst the material either in my possession or available to me there are many representatives of practically all families in the order and the following notes on a family of Brachycera may have some value to students of the Diptera of Australia.

I have been in possession for some years of material in certain genera of this family from New Zealand and Australia, but press of other work has prevented me from offering any observations on the species. Miller in 1917 published a paper in which he dealt with a few genera, and in 1921 Enderlein published a paper in which were included notes on certain New Zealand and Australian genera (*Mitt. Zool. Mus. Berlin*, Bd. 10, heft 1, pp. 153-214).

I have decided that in view of the interest taken in the geographic distribution of genera a few notes on some of the material before me would be appropriate at this time, especially as some students consider that there is a very decided affinity between the Australian fauna and that of South America rather than with that of the Oriental region and particularly with the Aethiopean region. I incline to the opinion that in the present state of our knowledge of generic limits any conclusions drawn must be based upon rather unstable grounds, but possibly the notes below will provide grounds for thought along these lines.

If one examines the various papers dealing with the family Stratiomyiidae there will be found a great similarity of treatment, but few departures from the accepted methods having taken place within the past half century, all of the authors confining their definitions and distinctions of genera to the characters presented in the structure of the antennae, wing venation, armature of the scutellum, and the abdomen. It is remarkable that in most of the tribes, or subfamilies if one elects to call them that, there is a quite commendable adherence to the general plans as specified by the various authors of these papers, but there is one subfamily, the Pachygastrinae, in which development of antennal and scutellar characters has run riot, and an appalling number of poorly represented genera has been proposed. There are almost a hundred of them now on record, and many of them are monobasic. Fortunately this is exceptional in the family, there being more stability in the other subfamilies.

In the course of my investigations to discover whether there were any supplementary characters for the segregation of doubtful forms, I found that there were some present which had been ignored by preceding writers dealing with the family.

One instance of a striking character that is unmentioned is the presence of erect upwardly directed hairs on the prominent convex metanotum of the Sarginae, and the existence close to the base of each halter on its mesial side of a short piliferous tubercle. The great majority of the genera of other subfamilies before me lack hairs on the metanotum, and it may therefore be proper to consider their occurrence in other groups as of more than specific import. In fact it appears to be possible to distinguish the genus *Stratiomyia* from *Odontomyia* by this character, the former having erect metanotal hairs and the latter lacking them. One exception to this rule is *Odontomyia vertebrata* Say, a North American species, but in it the metanotum has very short pale tomentum which adheres closely to the surface and is quite distinct from the erect well developed hairs present in *Stratiomyia*.

To carry the matter further, and to apply it to an Australian example, I may cite *Neoexaireta spinigera* Wiedemann.

The genus *Neoexaireta* and some closely related to it bear a very striking resemblance to the Xylophagidae, there being very little difference between the head of *Neoexaireta* and *Xylomyia*, and the wing venation being quite similar except in a few details. The costal vein is rather faint behind the wing tip in *Xylomyia*, but in the present genus and its allies it is lacking on the hind margin. The Xylophagidae known to me all have strong apical tibial spurs, while none are present in Beridinae, and it is noteworthy that the postscutellum, or upper convex portion of the metanotum, is very prominently convexly developed in *Neoexaireta* and its allies, and almost undeveloped in Xylophagidae. In some Beridinae this feature is rather poorly shown. We are, however, not at this time interested in this major grouping, merely introducing it because Enderlein in the paper already referred to has considered the Xylophagidae as a subfamily of Stratiomyiidae on a par with Beridinae, in which latter group he includes *Neoexaireta* and its allies.

Subfamily Beridinae.

Genus Neoexaireta Osten-Sacken.

This name was proposed to replace *Exaireta* Schiner which was preoccupied. The genotype is *spinigera* Wiedemann, a species which occurs in New Zealand, Australia, and Hawaii.

I have before me many specimens from all three countries and find that on each side of the convex metanotum there are many white *downwardly directed* hairs, and there are less conspicuous hairs on the pteropleura. Both of these portions of the thorax are bare in the other species placed in *Exaireta* by Hutton and Miller which I have before me. It is also noteworthy that the South American species which have been referred here have the metanotum bare, but in them the pteropleura is haired in part. It is also worth mention that the anal lobe of the wing, or alula, is much larger in *Neoexaireta* than it is in the other two genera.

Enderlein has erected a genus, *Exaeretina*, for the reception of a Chilean species, *aurocoma* Enderlein, distinguishing the genera on the presence of a

preapical transverse furrow on tergites 2 to 6 in *Neoexaireta* and on tergites 2 to 5 in *Exaerctina*. In the New Zealand species with bare metanotum there is a distinct transverse impressed line on the sixth tergite, so that in this character they differ from the Chilean species. I have examined a number of South American species which would be referable to *Exairetina* and in all the pteropleura is partly haired, so that I incline to the opinion that we have three recognizable genera, or if one prefers it so subgenera, distinguished as follows:

1. Sides of metanotum and part of pteropleura haired; alula well developed ..... *Neoexaireta* Osten-Sacken
   Metanotum bare; alula not at all or poorly developed 2
2. Pteropleura bare ..... *Huttonella* Enderlein
   Pteropleura haired in part ..... *Exaeretina* Enderlein

NEOEXAIRETA SPINIGERA Wiedemann.

As indicated above this is the only species I consider belongs to the genus. With the segregation of this species the distribution of the genus is limited to Australia, New Zealand, and Hawaii, but I should expect to it occur in some of the intervening Pacific Islands.

Genus HUTTONELLA Enderlein.

Both Enderlein and Miller segregated *Exaireta alpina* Hutton from the other New Zealand species placed in *Exaireta* by Hutton on the basis of the presence of but three veins emanating from the discal cell. Enderlein erected a new genus for its reception, and pointed out that there is a slight angle on the discal cell at the point where the usual vein is missing. Miller had only the type specimen of *alpina* before him and placed the species in the genus *Berismyia*, an American genus which differs in several respects from *alpina*.

In my opinion the type specimen of *alpina* is abnormal and the species should not be separated from the others placed in *Exaireta* by Miller, all of them being referable to *Huttonella*.

I have a number of the New Zealand species before me, but am unable to identify all of them for lack of sufficient material to permit me to judge the limits of variation in colour in the sexes.

It should be noted that *seolforalis* Miller may lack the third vein emanating from the discal cell and then the only character that would distinguish *alpina* would be the slightly lower placed antennal insertions, which latter in themselves do not amount to very much as generic indices in this group, unless strikingly below or above the middle of eyes, and in *alpina* they are very slightly below middle. In Miller's key to the species of this genus there is but one species listed with very dense silvery pubescence on dorsum of abdomen, but I have at least two such species from New Zealand.

Genus NEACTINA Enderlein.

This genus has the general habitus of *Beris*, but the hind femora are thickened from near bases to apices, in both the species before me they are at their thickest point at least three times as thick as the hind tibiae, and they are furnished on apical portion of ventral surface with many microscopic spinules. The upper portion of the hypopleura and the central portion of pteropleura are haired, and the eyes are pubescent. Third branch of media present, but incomplete.

Genotype, *Actina opposita* Walker, a New Zealand species. There is at least one other species of the genus occurring in New Zealand. There are no records from any other region.

Genus Beris Latreille.

It is extremely difficult to distinguish the genera related to *Beris*, and though the keys presented by Enderlein appear very good on paper, they are not at all satisfactory in practice. In dividing Beridinae into two tribes, Beridini and Actiini, he depends upon wing venation, citing the latter as having three branches to media and Beridini as having but two. In other words, with four or three veins emanating from the discal cell, the posterior one being the anterior branch of cubitus. As pointed out in the preceding discussion the third branch of media is quite variable in length, and may in some cases be absent in specimens of a species in which it is normally present rudimentarily. Thus the selection of this character for the separation of tribes is hardly one to be commended. In fact Enderlein evidently did not bear the character in mind when he drew up his keys as he included *Actina*, in which the species normally have but two branched media, and *Huttonella*, in which the only species has the same character, in the group which he states has three branched media.

At present we are concerned only with the Australian and New Zealand forms and will leave consideration of extralimital genera to others, though of course the available genera are used in determining the value of the characters as generic indices.

No species referable to *Beris* or closely related genera has hairs on the upper convex portion of the metanotum so they may readily be separated from *Neoexaireta*. From *Huttonella* most of the species may be at once separated by the presence of hairs on either the pteropleura or the hypopleura, or on both, or, if these are absent, by the lack of microscopic spinules on the apical portion of ventral surface of hind femora. The hind femora in all species of *Huttonella* and *Neoexaireta* are gradually swollen from near base to apex and the apical third or less of the ventral surface is furnished with microscopic stiff spinules. The only other genus of Beridinae from New Zealand in which this character occurs in *Neactina* Enderlein, and in it both the pteropleura and hypopleura are haired in part.

Using as a basis the characters of the genotypes of the European genera recorded from New Zealand and Australia, and the characters of the species now before me, I present the following key for the recognition of those now available to me in so far as the genera are concerned.

Key to the genera.

1. Hind femora thickened apically and with microscopic stiff spinules on apical third or less on ventral surface which are distinct from the long fine hairs 2
   Hind femora not very noticeably thickened, or, if slightly so, then without microscopic stiff spinules, only fine hairs present 4
2. Metanotum with quite long downwardly directed white hairs on each side of upper convex portion; pteropleura haired in part; alulae well developed ..... *Neoexaireta* Osten-Sacken
   Metanotum without evident hairs on upper convex portion 3
3. Pteropleura and hypopleura bare ..... *Huttonella* Enderlein
   Pteropleura and hypopleura haired in part ..... *Neactina* Enderlein
4. Complex antennal segment (apparent third) not longer than first and second segments combined; scutellar spines slightly thickened or knobbed at apices ..... *Berisina*, n. gen.

Complex antennal segment much longer than first and second combined; scutellar spines tapered to apices 5
5. Pteropleura bare; eyes of male bare or almost so, and not touching ..... *Chorisops* Rondani
Pteropleura haired in part 6
6. Palpi rudimentary ..... *Beris* Latreille
Palpi well developed, projecting ..... *Actina* Meigen

It will be seen from the above key that, even using the characters listed, we find *Actina* and *Beris* running very close together, and though *Chorisops* appears to be better distinguished, I found in the material in the United States National Museum two distinct species standing as one, and evidently so named by Bezzi. One of them has the centre of the pteropleura with fine hairs and the other has the pteropleura bare. Using only the characters of width of frons and presence of hairs on the eyes one will get different groupings than in using the above listed characters, but I believe the latter to be the best and, as they can be applied to both sexes, they are better for the purpose of associating the sexes.

I have seen no species of *Beris* from Australia or New Zealand.

Genus Actina Latreille.

There is at least one species referable here which I have seen from Australia, *victoriae* Hill, but whether it is identical with one of the species included in the genus by Enderlein I cannot say. The species so included are *filipalpis* Macquart, *fusciventris* Macquart, *incisuralis* Macquart, *nitidithorax* Macquart, and *nigricornis* Enderlein. Only *incisuralis* is recorded from Australia, the others are from Tasmania. White has recorded other species, but his concept is different.

The New Zealand species recorded by Miller as belonging to *Actina* are now in *Neactina*.

Genus Chorisops Rondani.

There is one species before me, which appears to be *lacuans* Miller, that may properly be referable to this genus, but I have only one female and do not care to give a definite opinion on a single specimen, especially as I am not certain of its specific identity.

Genus Berisina, nov.

Despite the multiplicity of genera in this group I feel that the species now before me can safely be referred to a new genus.

In structure rather more robust than typical species of *Beris*, the mesonotum not longer than its greatest width, and the scutellum nearly twice as wide as long, with the apex almost transverse, and the four spines short and slightly thickened apically. Eyes not touching above in male, with quite long hairs centrally, becoming very short haired above; frons and face long haired, the latter widened below; basal antennal segment fully three times as long as thick and longer than second, the two combined longer than the complex third segment, the latter indistinctly segmented, terminating in a short point, and haired at apex; palpi well developed, with numerous quite long apical hairs. Pteropleura haired in part, hypopleura bare. Hind femora and tibiae thickened apically, the latter thicker than femora, basal segment of hind tarsus thickened. Venation as in *Beris*, three veins emanating from discal cell.

Genotype, the following species.

Berisina maculipennis, n. sp.

Male.—Glossy black, base of hind metatarsus slightly yellowish; wings fuscous, with two hyaline spots, one between the stigma and fork of radius, the other in apex of anterior basal cell. Hairs all black.

Frons about as wide as third antennal segment. Many of the hairs on dorsum of thorax, including the scutellum, long and erect, with a secondary short hairing between them. Wings extending beyond apex of abdomen. Fourth tarsal segment the shortest on all legs.

Length, 5·5 mm. to apex of abdomen.

Type and two male paratypes, Wanganui, New Zealand (M. M. Watt).

The type specimen will be returned to New Zealand for disposition in some museum where it will be available to students in the country of origin.

Genus Metoponia Macquart.

I have before me three specimens of the genotype. The genus is closely related to the American *Allognosta* Osten-Sacken, and was placed with it and several other genera in the tribe Metoponiinae by Enderlein in his work already referred to herein. Practically the only character useful in distinguishing the group from Beridinae is the lack of scutellar spines, which in my opinion is insufficient to justify the separation of the group from Beridinae either as a tribe or subfamily. I have only male specimens before me and the following characters are drawn from that sex.

The eyes are finely haired, and closely contiguous on most of the frons; basal antennal segment about four times as long as thick, second much shorter, third (complex) segment longer than the two basal segments combined, with rather evident annulations, and a deep broad sulcus or channel along one side on all except the basal segment of the complex; insertion of antennae well below middle of face, the head almost horizontal from lower margin of insertions of antennae to mouth; palpi small but distinct. Pteropleura and hypopleura without distinct hairs; scutellum without spines. Fourth segment of all tarsi as long as fifth. Three veins emanating from discal cell.

Metoponia rubriceps Macquart.

Three males, Botany Bay, N.S.W. (H. Peterson). The specimens were sent to me by the late Dr. C. F. Baker.

Subfamily Pachygastrinae.

I have already indicated in this paper that the subfamily Pachygastrinae has been very freely handled in so far as the erection of genera is concerned, and it is time someone with an eye to affinities indicated by more reliable indices than the structure of the antennae and scutellum gave the matter of generic limits his careful attention. Unfortunately the insects are not at all common and it will be very difficult to get enough material to check up the work already done on the group, not to mention obtaining the types of the already established genera for examination.

However, an intensive study of the genera available in Australia and Tasmania would do much to determine whether trivial differences in the two characters mentioned ought to be given weight in separating genera in the subfamily.

Before me there are several species which, according to present criteria, ought in the main to be placed in distinct genera, but I have insufficient material to do good critical work so merely offer a few notes.

Genus Lonchaegaster White.

This genus was erected for the reception of a Tasmanian species, *armata* White, of which I have a specimen before me.

If the species is run through the generic key to Pachygastrinae published by Kertesz it will run down to *Prostomomyia* Kertesz. The latter, however, is not the first name for the genus, *Monacanthomyia* Brunetti apparently being the first in line of acceptance, with *Ceratothyrea* de Meijere coming second. All three genera were erected for Oriental species and though it is possible that the species are not all the same they undoubtedly belong to the same genus, *Monacanthomyia*.

The Tasmanian species I consider is distinct from the others. I have seen a specimen from Townsville, Qld. (G. F. Hill).

Genus Pachygaster Meigen.

I have before me a species which appears to be congeneric with an American one referred here. The antennae are short, with the third segment disc-like, and the scutellum is rounded in outline, and has some very minute warts along part of the lower lateral margin on each side. Of the two species described by Hardy, it most closely resembles *whitei*, but there are fewer warts along the sides of scutellum than he gives as the number distinguishing that species. However, this character is not a very reliable one for distinguishing species when they amount to more than six or eight.

Locality, Brisbane, Qld., in house (A. J. Turner).

It is extremely probable that careful search under bark of trees will discover the larvae of these species and provide material for a comparative study of the insects. In fact I have found the species only in this sort of habitat and amongst the material before me from Australia there is one species which was reared from larvae found under dead bark.

THE TANYDERIDAE OF AUSTRALIA (DIPTERA).

By Charles P. Alexander, Massachusetts Agricultural College,
Amherst, Massachusetts, U.S.A.
(*Communicated by Dr. I. M. Mackerras.*)

(Four Text-figures.)

[Read 29th August, 1928.]

The remarkably paleogenic group of Diptera now included in the family Tanyderidae is represented by ten recent and fossil genera totalling slightly more than a score of species. Of this number, three genera with four species are herein recorded from the Australian Subregion. For many years the flies of this group were included in the family Tipulidae where they were ranked as a distinct tribe or placed with the Ptychopterini (Loew, 1851; Osten Sacken, 1859, 1869, 1880, 1886; Philippi, 1865; Hutton, 1900). More recently the various Tanyderid genera were distributed in the Ptychopteridae (Handlirsch, 1909; Enderlein, 1912; de Meijere, 1915*a*, 1915*b*). The group was finally accorded full family rank by Alexander (1919).

The first genus to be described was the only known fossil, *Macrochile* Loew (Loew, 1851; Crampton, 1926; Alexander, 1927*b*) from the Lower Oligocene Baltic Amber. The next genus to be defined was *Protoplasa* Osten Sacken (1859), soon followed by the typical genus *Tanyderus* Philippi (1865). Virtually all of the known species, including all forms described from the Southern Hemisphere, were included in *Tanyderus* until the appearance of the very important paper by Handlirsch (1909) where three new generic groups were proposed (*Protanyderus*, *Mischoderus* and *Radinoderus*). Alexander (1927*b*) recognized these three names as valid subgenera and added two subgeneric groups to *Tanyderus*, *Neoderus* for the Neotropical *Tanyderus patagonicus* Alexander (1913) and *Nothoderus* for the Australasian *Tanyderus australiensis* Alexander (1922). It now seems advisable to treat these names as was done by Handlirsch and in the present report a total of ten generic names is recognized. The most distinct group would appear to be *Péringueyomyina* Alexander (1921), although many of the other groups appear to be very well defined. In the Australasian fauna, *Mischoderus* Handlirsch is found only in New Zealand, a total of five specific names having been proposed (*forcipatus* Osten Sacken, 1880; *annuliferus* Hutton, 1900; *neptunus* Edwards, 1923*a*; *varipes* Edwards, 1923*a*; *marginatus* Edwards 1923*b*) at least one of which will probably prove to be a synonym (Handlirsch, 1909; Tillyard, 1926). *Radinoderus* Handlirsch includes six Australasian and an additional Chilean species (*gloriosus* Alexander, 1920*b*). The species of the former group have been discussed and keyed in a paper by the writer (Alexander, 1924). Two of the Australian species belong to *Radinoderus* and are the largest and most beautiful species in the local fauna. *Nothoderus* Alexander is probably the most generalized of the living Tanyderidae, its retention

of the free tip of Sc_2 being an archaic feature (Alexander, 1922, 1927*a*, 1927*b*; MacGillivray, 1923). The third Australian genus includes only the very interesting little species that is described herewith as *Eutanyderus wilsoni*, n. gen. et sp., one of the interesting captures made in Victoria by my friend, Mr. F. Erasmus Wilson.

In earlier papers, the writer (Alexander, 1920*c*, 1927*b*) had included in the Tanyderidae as a separate subfamily the Bruchomyinae but these are now considered as being more properly referable to the Psychodidae (Alexander, Proc. Linn. Soc. New South Wales, liii, 1928, 291).

Nothing is known concerning the immature stages of these flies except the brief account given by Alexander (1920*a*) of the supposed larva of *Protoplasa fitchii* Osten Sacken. This larva lives in wet decaying logs near water and presents a curious appearance, the caudal end of the abdomen being produced into a long, stout, non-retractile breathing tube that is somewhat suggestive of the much shorter tube of the closely allied Psychodidae. At the base of this tube are two large, pinnately branched anal gills that are quite unlike those of any other known Dipterous insect.

Key to the Genera of the Tanyderidae.

1. Front prolonged into a slender rostrum that is longer than the combined head and thorax, the reduced mouthparts being borne at the extreme apex; wings immaculate; male hypopygium with the styli very elongate ..... (Ethiopian: Cape Colony) .... *Péringueyomyina* Alexander

   Front not greatly prolonged, the rostrum being relatively short, any elongation that exceeds the remainder of the head in length being due to the palpi and other mouthparts; wings pictured in all recent species; male hypopygium with the styli short 2

2. Wings immaculate ..... (Fossil: Lower Oligocene, Baltic Amber) ..... *Macrochile* Loew

   Wings pictured, the pattern usually cross-banded brown and subhyaline 3

3. Wings with the free tip of Sc_2 preserved ..... (Australasian: Tasmania) ..... *Nothoderus* Alexander

   Wings with the free tip of Sc_2 atrophied 4

4. Cervical sclerites shorter than the pronotum, the neck-region short; male hypopygium with the dististyle more or less bifid 5

   Cervical sclerites elongate, equal to or exceeding the pronotum, the two together forming a conspicuous neck-region; male hypopygium with the dististyle simple, terete 6

5. A supernumerary cross-vein in cell M_3 of the wing ..... (Eastern Nearctic) ..... *Protoplasa* Osten Sacken

   No supernumerary cross-veins in any cells of the wing ..... (Western Nearctic, Palaearctic) .... *Protanyderus* Handlirsch

6. No supernumerary cross-veins in any cells of the wing 7

   Supernumerary cross-veins in certain of the radial cells of the wing 8

7. Rs elongate, subequal to or exceeding R_{2+3}, the latter shorter than cell R_2; in Australian species a short fusion of R_{2+3+4}; antennae with 18 or more segments ..... (Australasian, Neotropical) ..... *Radinoderus* Handlirsch

   Rs short, about two-thirds R_{2+3} and longer than cell R_2; R_{4+5} distinct from R_{2+3}; antennae with 15 segments ..... (Australasian: Victoria) ..... *Eutanyderus*, n. gen.

8. A supernumerary cross-vein in cell R_4 only ..... (Neotropical: Chile) ..... *Tanyderus* Philippi

   Supernumerary cross-veins in two radial cells 9

9. Supernumerary cross-veins in cells R_3 and R_4 ..... (Australasian: New Zealand) ..... *Mischoderus* Handlirsch

   Supernumerary cross-veins in cells R_3 and R_5 ..... (Neotropical: Patagonia) ..... *Neoderus* Alexander

NOTHODERUS Alexander.

Nothoderus Alexander, PROC. LINN. SOC. NEW SOUTH WALES, lii, 1927, 45; Alexander, *Genera Insectorum*, Fasc. 189, 1927 (Tanyderidae).

Front elongate, about twice the length of the remainder of the head, the maxillary palpi basal in position, longer than the frontal prolongation. Eyes hairy. Vertex between the eyes narrow. Antennae 15-segmented, short in both sexes, the flagellar segments in the male cylindrical, the outer segments more oval; first segment of scape only a little longer than the second. Cervical sclerites relatively short, subequal to or shorter than the pronotum which is large and massive. Legs relatively short and stout, hairy, the tibial spurs distinct; claws slender, nearly straight. Wings with the general venation of *Tanyderus*; Sc_1 atrophied; free tip of Sc_2 preserved (Text-fig. 1), the fusion of Sc_2 and R_1 subequal to or a little exceeding the free tip itself; a single supernumerary cross-vein at near two-thirds the length of cell R_4; cell 1st M_2 very long and narrow, only slightly widened distally; m-cu short, a little more than its own length beyond the fork of M_{3+4}. Veins with conspicuous macrotrichiae. Male hypopygium with the basistyle slender, only moderately clothed with setae. Dististyle terminal in position, cylindrical, gently arcuate, at the apex densely provided with erect spinous bristles; mesal face of style with scattered erect setae that are intermixed with smaller delicate setulae. What appears to represent the tergite is a bilobed structure with a microscopic glabrous lobe in the emargination, the large lateral lobes armed with stout spinous setae; more basal in position are two lobules that are provided with a group of very long slender black setae. Aedeagus apparently simple at apex, relatively short, curved.

Genotype, *Tanyderus australiensis* Alexander (Australasian Region: Tasmania).

NOTHODERUS AUSTRALIENSIS (Alexander).

Tanyderus australiensis Alexander, *Rec. South Australian Museum*, ii, 1922, 226-227; MacGillivray, External Insect-Anatomy, 1923, p. 322, fig. 45 (wing).—*Tanyderus* (*Nothoderus*) *australiensis* Alexander, *Genera Insectorum*, 1927, Fasc. 189, fig. 9.—*Nothoderus australiensis* Alexander, PROC. LINN. SOC. N.S.W., lii, 1927, 45, fig. 1.

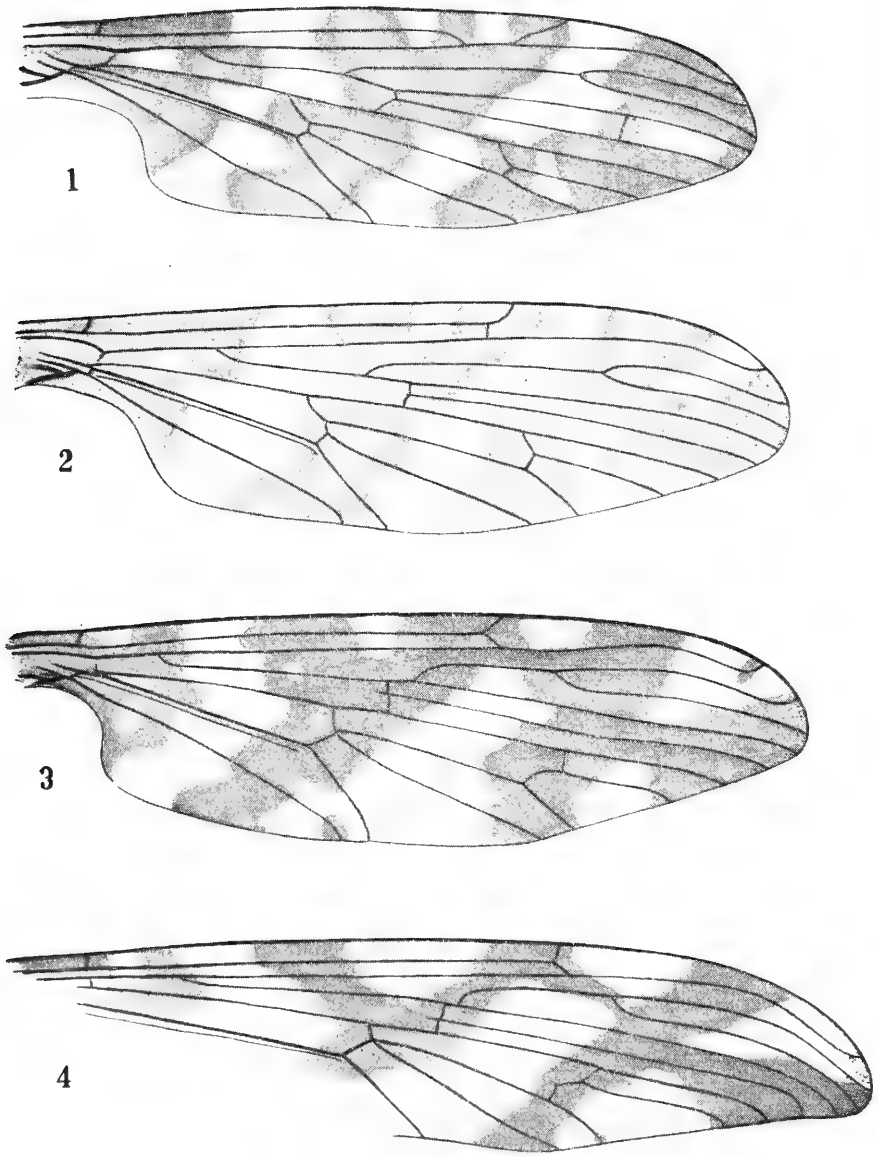
The type, a unique female, was from Southport, Tasmania, and is now preserved in the South Australian Museum. Dr. Tonnoir secured a male in the Hartz Mountains, Tasmania, altitude 3,000 feet, December 10, 1922, and a second female specimen on Mt. Wellington, November 28, 1922. These are the only records known to me and the fly is apparently confined to southern Tasmania.

Allotype, ♂. Length about 5·8-6 mm.; wing 7·5 mm.

Agreeing closely with the female except in the smaller size (♀, length, excluding rostrum, about 9 mm.; wing 10·5-11 mm.; rostrum alone 1·3-1·4 mm.) and sexual characters.

Pronotum and mesonotum reddish-brown, the prescutum with three broad blackish stripes; pronotum and mesonotum with conspicuous erect yellow setae. Wings with a pattern that is similar to the type female (Text-fig. 1) with the following exceptions: The brown spot at origin of Rs not confluent with the marking in the anal angle; as in the type, the broad fascia at the cord divides into three rays in the costal region, the second including Sc at its point of disappearance into R, the third surrounding the free tip of Sc_2.

Allotype, ♂, Hartz Mts., Tasmania, altitude 3,000 feet, December 10, 1922 (A. L. Tonnoir). The allotype and the female specimen taken by Dr. Tonnoir have been returned to him. His female agrees closely with the type (Text-fig. 1) except that the third apical dark area at outer end of cell 1st M_2 is barely



Text-fig. 1.—Wing of *Nothoderus australiensis* (Alexander); holotype ♀.
Text-fig. 2.—Wing of *Eutanyderus wilsoni*, n. gen. et sp.; allotype ♀.
Text-fig. 3.—Wing of *Radinoderus terrae-reginae* (Alexander); holotype, sex ?
Text-fig. 4.—Wing of *Radinoderus occidentalis* (Alexander); holotype ♀.

contiguous with the second apical spot, but broadly connected with the wide central fascia by rays in cells R_5 and M_3, leaving an oval white spot in cell 1st M_2 and the adjoining part of cell M_3.

EUTANYDERUS, n. gen.

Frontal prolongation of the head short, less than one-half the remainder of the head; both labial and maxillary palpi elongate, slightly exceeding the entire remainder of the head, the maxillary palpi a little longer than the labial palpi; terminal two segments of maxillary palpi relatively short, subequal to the antepenultimate. Antennae 15-segmented, relatively short, only a little longer than the combined front and mouthparts; flagellar segments cylindrical or nearly so, with basal verticils that are shorter than the segments. Eyes hairy. Cervical sclerites equal to or longer than the pronotum, the two together producing a conspicuous elongate neck-region as in this group of genera. Legs with conspicuous, nearly erect setae on the tibiae and less conspicuous setae on the femora; tibial spurs distinct; tarsal segments one to four with paired spinous setae. Wings (Text-fig. 2) pictured, more heavily so in the female than in the male; Sc relatively short, Sc_1 ending about opposite one-half to three-fifths the length of R_{2+3}, Sc_2 a short distance from its tip; Rs relatively short, gently arcuated at origin; R_{2+3} longer than either R_2 or R_3; R_{4+5} more than one-fourth Rs; basal section of M_4 nearly equal to m-cu; no supernumerary cross-veins in any cells of the wing. Male hypopygium with the dististyle cylindrical, gently arcuated, a little longer than the basistyle. Ovipositor with small fleshy valves.

Genotype, *Eutanyderus wilsoni*, n. sp. (Australasian Region: Victoria).

Despite the points of divergence offered by the structure of the neck region and the venation, I believe that *Eutanyderus* is most closely allied to *Nothoderus* Alexander.

EUTANYDERUS WILSONI, n. sp.

Size small (wing less than 10 mm.); mesonotal prescutum with four brown stripes; fore coxae paler than the other coxae; femora tipped with black; wings nearly hyaline with a conspicuous banded pattern, very pale in the male, darker in the female, the areas narrowly margined with still darker brown.

♂. Length (excluding rostrum) about 7 mm.; wing 8·5 mm.; rostrum about 1·5 mm.

♀. Length (excluding rostrum) about 7 mm.; wing 8·5 mm.; rostrum about 1·4 mm.

♂. Rostrum and palpi black. Antennae with the scapal segments brown, the first flagellar segment yellow; second flagellar segment pale brown, brighter at the sutures; remaining segments brownish-black, the third and fourth segments a trifle brightened at the sutures. Head dark grey.

Cervical sclerites brownish-grey. Pronotum dark grey, with conspicuous erect white setae. Mesonotal prescutum light fulvous, with conspicuous white setae and four dark brown stripes, the intermediate pair longer and weakly separated by a pale vitta; scutum obscure yellow medially, the lobes dark brown, the lateral margins fulvous; scutellum broad, light yellow, with pale setae; postnotal mediotergite reddish-brown with a darker brown median line. Pleura grey with a reddish cast, the dorsal region darker. Halteres pale yellow, the knobs dark brown. Legs with the fore coxae and trochanters yellow, the remaining coxae concolorous

with the pleura; middle and posterior trochanters obscure brownish-yellow; femora yellow, the tips narrowly blackened; tibiae brown; tarsi passing into brownish-black; hind legs broken. Wings nearly hyaline, with a pale pattern that is only a trifle darker than the ground-colour, these areas narrowly margined with darker brown; these pale fasciae are distributed as follows: Origin of Rs; an irregularly oblique fascia completely crossing the wing at the cord, sending two rays to the costal margin, the outer at the tip of Sc; three extensive apical areas, the first surrounding the fork of R_{2+3}, the second apical in position, the third including the outer end of cell 1st M_2 and thence to the caudal margin; the first and second areas are contiguous basally, separated by a narrow arm of the ground colour; the third ray is distinctly separated from both of the others; an axillary area in both anal cells. This arrangement of pattern is exactly as in the female, as figured (Text-fig. 2).

Abdominal tergites obscure yellow, the lateral margins narrowly darker; hypopygium dark brown; sternites more yellowish-brown, the lateral margins infuscated, the caudal margins of the individual segments narrowly pale.

♀. Generally similar to the male, differing in details of coloration. Ground colour of the prescutum and scutum duller, more testaceous; scutellum somewhat testaceous brown. The posterior tarsi are much paler yellow than the other tarsi. Wings (Text-fig. 2) with the pattern heavier than the male, the central portions of the various fasciae being only a little paler than the margins; prearcular region and bases of cells C, Sc, R, M, Cu and the anal cells darkened. Abdominal tergites pale brown, the caudal margins of the segments narrowly darker brown.

Hab.—Victoria.

Holotype, ♂, Mountains near Millgrove, altitude 2,000 feet, October 23, 1927 (F. E. Wilson); returned to Mr. Wilson, to be placed eventually in the National Museum, Melbourne.

Allotype, ♀, with the male, at 2,300 feet; in the author's collection.

This striking addition to the Victorian fauna is named in honour of the collector, Mr. F. Erasmus Wilson, to whom I am greatly indebted for many kind favours.

Radinoderus Handlirsch.

Ann. k.-k. Naturhist. Hofmus. Wien, xxiii, 1909, 270.

The genotype of *Radinoderus*, *ornatissimus* (Doleschall) is known only from the islands of Amboina and Obi (Osten Sacken, 1886; Enderlein, 1912). Two other species, *mirabilis* (de Meijere) and *oculatus* (Riedel), are from New Guinea, while a fourth, *solomonis* (Alexander), is from the Solomon Islands. The other Australasian species are from Australia and may be separated by means of the following key:

1. Wings broad with a heavy brown pattern, the costal rays much more extensive than the interspaces; all femora yellow with the tips broadly blackened ..... (South Queensland) ..... *terrae-reginae* (Alexander)
   Wings narrow with a more restricted brown pattern, the pale costal interspaces being more extensive than the dark rays; at least one of the femora (probably the fore pair) has a broad and conspicuous blackened ring at near midlength, in addition to the blackened tips .. (Western Australia) .. *occidentalis* (Alexander)

No further data have become available concerning these two species and their descriptions are briefly summarized here only to complete the subject.

RADINODERUS TERRAE-REGINAE (Alexander).

Tanyderus (*Radinoderus*) *terrae-reginae* Alexander, *Insec. Inscit. Menst.*, xii, 1924, 141-142.

Antennae 24-segmented; scape black, the flagellum entirely light yellow. Mesonotum pale brown with three darker brown stripes; scutellum yellow, the caudal margin and a median line dark brown; pleura dark brown, variegated with paler. Halteres yellow, the knobs dark brown. Legs yellow, the tips of the femora broadly blackened, the bases of the tibiae similarly and subequally blackened; tarsi yellow. Wings (Text-fig. 3) whitish subhyaline, the pattern brown. Abdomen dark brown, the tergites with an oval whitish marking on either side.

Brisbane, October 10, J. A. Kershaw. Type in the National Museum, Melbourne.

RADINODERUS OCCIDENTALIS (Alexander).

Tanyderus (*Radinoderus*) *occidentalis* Alexander, *Insec. Inscit. Menst.*, xiii, 1925, 32-34.

Allied to *terrae-reginae*, differing in the following regards:

Femora yellow, the fore femora (presumably) conspicuously blackened at near midlength; on the middle femora (presumably) this region is merely infuscated. Wings (Text-fig. 4) relatively narrow, the tips subfalcate; membrane whitish subhyaline, the brown pattern narrow and restricted in amount, with a Y-shaped marking at the cord, the outer arm, at tip of Sc, confluent with an X-shaped area that occupies the distal third of the wing.

Swan River, Western Australia (J. Clark).

The unique type was sent to me by my friend, the late Dr. Eustace W. Ferguson. The drawing provided herewith was made from the badly folded wing of the type and the basal portions could not be accurately figured. The type was returned to Dr. Ferguson.

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NEW SPECIES OF AUSTRALIAN ERIRHINIDES (CURCULIONIDAE).

By Arthur M. Lea, F.E.S.

[Read 25th July, 1928.]

The species here dealt with are all small, but one of them (*Glaucopela nidicola*) is of special interest, as it was obtained in large numbers from a bird's nest in the arid district of Ooldea.

Glaucopela nidicola, n. sp.

Black; antennae, tibiae and tarsi reddish. Densely clothed with brownish-grey scales, variegated with sooty and whitish ones on upper surface, becoming uniformly white on under surface and legs. A row of depressed setae on each elytral interstice.

Rostrum about the length of prothorax, shining, curved, and with sharply defined punctures. Prothorax strongly transverse, sides strongly rounded, base much wider than apex. Elytra subcordate, base gently and evenly arcuate, with rows of large punctures appearing much smaller through clothing. Under surface strongly convex. Legs short. Length, 2·5-3·0 mm.

South Australia: Ooldea (A. M. Lea).

Distinct from all previously described species of the genus by its entirely black rostrum. In general appearance, except for its larger size, it is somewhat like *G. instabilis* and *G. fuscomarmorea*. The clothing on the upper surface is somewhat variable; on the pronotum there is usually a pale median line and the sides are widely pale; on the elytra there is usually a sooty fascia or series of spots crowning the apical slope, beyond which many of the scales are whitish. Many specimens have the elytra obscurely mottled. The male differs from the female in having a shallow depression on the two basal segments of abdomen, and about the basal fifth of rostrum clothed. More than one hundred specimens were taken from a bird's nest on a small wattle tree, and hundreds more could have been obtained. Two damaged specimens, apparently belonging to this species, were taken at Cue (Western Australia) by Mr. H. W. Brown.

Desiantha malevolens Lea.

A variable and widely distributed species with scales as dense on under parts as on prothorax and elytra; on each of the latter there is always a distinct pale spot on the third interstice beyond the middle. The abdomen of the female has a depression similar to that of the male, except that it is somewhat shallower (two specimens, still fast *in cop.*, are before me).

Var. vegrandis Lea.—A common variety in New South Wales, which is consistently smaller than the typical form, and usually has nine vittae on the pronotum, four dark and five pale (the latter often with a golden gloss); the vittae, however, are sometimes broken up into spots, or two of the pale ones may vanish.

In the interior parts of South Australia (Parachilna, Cooper's Creek, Kingoonya, Mount Painter, Farina, Oodnadatta, Bimbowrie, and the N.E. corner)

a variety is common in which the clothing of the upper surface is of a pale coppery-buff colour, becoming paler on the sides, but with the postmedian spots fairly distinct.

Specimens from Queensland (Cunnamulla, Brisbane, Dalby, Stewart River, etc.) vary from having the scales almost entirely pale brown or buff, to almost entirely dark brown, and the prothorax with a variable number of vittae or spots. Two specimens from Bowen have the scales of the upper surface sooty-brown and slaty-white, the latter forming a large basal spot on each side of the pronotum and a small medio-basal one—on the elytra they cover about one-third of the surface; the postmedian spots are present but not isolated. A specimen from Derby (North Western Australia) has similar prothoracic markings, but the pale parts of the elytra are smaller in extent. On an occasional specimen the pale scales of the upper surface have a faint bluish tinge.

Desiantha ferruginea, n. sp.

♂. Black; parts of antennae and of legs obscurely diluted with red. Densely clothed with rusty slightly variegated scales. Rather densely setose, the setae on the elytra long and suberect.

Rostrum moderately stout, the length of prothorax, with seven acute ridges partially obscured by clothing. Prothorax almost as long as its greatest width (about one-third from apex), sides rounded, base and apex subequal; with crowded, normally concealed punctures. Elytra about one-third wider than prothorax, rather long, parallel-sided to near apex, shoulders rounded; with rows of large deep punctures appearing very small through clothing, preapical callosities distinct and subfasciculate. Under surface with an elliptic depression common to metasternum and two basal segments of abdomen. Length (excluding rostrum), 9-10 mm.

♀. Differs in having the elytra bimucronate, the abdomen more convex, with the two basal segments feebly and not conjointly depressed in the middle.

Western Australia: Cue (H. W. Brown).

Allied to *D. major*, but the average size smaller, the clothing rustier and elytral setae more erect. The mucros of the female look like small fascicles, and are very similar on the females of that species (the male only was described by Blackburn). On several specimens the clothing on the upper surface is entirely rusty, but it is usually obscurely variegated with some slightly paler spots or patches and some small sooty spots; the pronotum is feebly trivirgate. On the abdomen and most of the metasternum the clothing consists solely of white setae, but on the prosternum, mesosternum and sides of metasternum there are some scales as well.

On this, as on most species of the genus with seven acute ridges on the rostrum, the ridges are often partially obscured by scales and setae which arise from dense punctures, the seven ridges are distinct at the base, but one on each side ends before the insertion of antennae, so that near the apex there are only five (sometimes only three); the apex itself is without ridges but is densely punctate.

Desiantha curvisetosa, n. sp.

♂. Black; parts of antennae and of tarsi obscurely reddish. Densely clothed with rusty scales obscurely variegated with paler and darker spots. With dense and not suberect setae. Length, 7·0-7·5 mm.

South Australia: Oodnadatta (Rev. T. Blackburn); Queensland: Cunnamulla (H. Hardcastle).

The two males before me at first glance appear to belong to the preceding species, but are at once distinguished by the elytral setae; these are much less conspicuous from the sides, and are so curved that their tips touch the scales amongst which they are set (on the apical slope, however, although curved, their tips are free); on the under surface, except on parts of the prosternum, the clothing consists solely of setae. Structurally also they are close, but differ from the male in having the prothorax slightly longer, elytra not quite so parallel-sided and the depression on the abdomen slightly shallower, and not distinctly joined to a depression on the metasternum (this is also smaller and shallower). On the Cunnamulla specimen the proportion of dark scales on the elytra is greater than on the type.

DESIANTHA INERMIS, n. sp.

♀. Black; antennae and parts of legs reddish. Densely clothed with obscurely variegated scales and numerous setae; on the under surface and legs with whitish setae only.

Rostrum about the length of prothorax, and with seven acute ridges. Prothorax about as long as its greatest width (slightly nearer apex than base) sides gently rounded, base and apex subequal; with crowded partially concealed punctures. Elytra rather strongly arcuate at base, shoulders strongly rounded, sides nowhere quite parallel; with rows of strong punctures normally almost or quite concealed; preapical callosities moderately distinct. Two basal segments of abdomen almost evenly convex, the intercoxal process with coarser punctures than elsewhere. Length, 6 mm.

North Western Australia: Derby (W. D. Dodd).

Somewhat resembles the preceding and *D. major* on a reduced scale, but elytra not mucronate. It has the general appearance of *D. assimilis* but the rostral carinae are different and the elytra (viewed from the sides) have conspicuous setae. The club is slightly darker than the rest of the antennae, and the tibiae are somewhat darker than the tarsi. On the head and rostrum the clothing is entirely rusty, the pronotum is feebly trivirgate, the scutellum appears as a whitish spot; on the elytra the clothing is so dense that the punctures are often hidden, although the striae are never quite concealed; about half of their scales are rusty, with obscure mottlings of slaty-white and sooty-brown. On the elytra all the setae are curved, but their tips do not touch the scales amongst which they are set, as on the preceding species, being throughout much as they are on the apical slope of that species. A male obtained at the same time as the type, but so badly abraded as to be unsuitable for a type, is slightly smaller than the female, has the elytra more nearly parallel-sided, and has a shallow elliptic depression common to the metasternum and the two following segments. The rostrum at first appears to have seven acute ridges traceable to between the insertion of antennae, three on each side being close together, the median carina being more distant than the others; between it and the one on each side of it on the female, the sculpture is concealed by the clothing, but from the male the setae were abraded and remnants of another, but very feeble, carina may be seen.

DESIANTHA TRIVITTICOLLIS, n. sp.

♂. Black; antennae and tarsi dull reddish, tibiae somewhat darker. Densely clothed with rusty-brown scales, becoming slightly paler about apex of elytra, but

elytra with numerous small irregularly distributed sooty-brown spots, pronotum with three conspicuous pale vittae. With numerous subdepressed setae, becoming uniform and almost white on under parts, each femur with a distinct subapical white ring.

Rostrum moderately stout, scarcely the length of prothorax, with seven acute ridges to near apex. Prothorax about as long as wide, sides almost evenly rounded; with crowded punctures. Elytra parallel-sided to slightly beyond middle, shoulders strongly rounded; striate-punctate, punctures large but appearing small through clothing, alternate interstices feebly elevated, preapical callosities distinct. Two basal segments of abdomen with a rather shallow median depression. Length, 7·5 mm.

Elder Expedition, Camp 5; unique.

The type was standing in the Blackburn collection with *D. maculata*, but was not commented upon when the Coleoptera of that Expedition were dealt with; it is much larger than *maculata* and has much larger abdominal punctures. It really belongs to the group about *D. major*, but is smaller than that species, and has subdepressed setae. The prothoracic vittae are conspicuous.

Desiantha foveata, n. sp.

♂. Black; antennae and tarsi reddish. Densely clothed with sooty-brown or slaty-brown obscurely variegated scales, and with numerous stiff, sloping setae; under parts setose.

Rostrum rather stout, dilated to near apex, with crowded punctures and three acute ridges. Prothorax slightly transverse, sides evenly rounded, apex somewhat convex in middle; with crowded punctures. Elytra parallel-sided for about half their length, shoulders strongly rounded; with rows of large, deep, partially concealed punctures, preapical callosities subfasciculate. Metasternum and two basal segments of abdomen with a deep excavation or fovea, apical segment with a fairly large impression. Length, 7-8 mm.

♀. Differs in having two basal segments of abdomen flat in middle, the apical one gently convex, the legs slightly shorter, and the front tibiae less curved at apex.

New South Wales: Upper Williams River (F. E. Wilson and A. M. Lea), Eccleston, in flood debris (J. H. Hopson), Sydney (Lea); Victoria: Portland (H. W. Davey).

A rather large species, with the general appearance of *D. praemorsa* and *D. nociva*, but without the sudden notch on each side of the rostrum of those species; the rostrum, however, has a feeble notch on each side, but it is distinct only from below. Its upper surface has three distinct ridges, and even on abrasion no others become visible. The tibiae, coxae, and parts of the abdomen are sometimes obscurely diluted with red. On some specimens the clothing is mostly sooty-brown, on others it is somewhat paler, but it is never very pale, and on the nine specimens before me there are no well-defined markings, although on some of them there is a feeble median vitta on the pronotum; in certain lights some of the scales have a slight coppery gloss. The seriate punctures on the elytra of the male are often wider than the interstices, but they usually appear much smaller through the clothing. All the tibiae are denticulate. On the Eccleston specimen the setae are suberect and the head has three fairly distinct spots of dark clothing; similar but less distinct spots may be traced on others.

DESIANTHA HUMERALIS, n. sp.

Black. Densely clothed with rusty-brown slightly variegated depressed setae.

Rostrum comparatively thin, with crowded setiferous punctures and with five partially concealed ridges. Prothorax subglobular, densely granulate-punctate, with a feeble median line. Scutellum large. Elytra with parallel sides from beyond shoulders to apical third, thence coarctate to tips, each shoulder with an oblique ridge; with rows of large deep, irregular punctures, alternate interstices slightly elevated (more noticeably at base), preapical callosities rather small. Under surface with crowded punctures. Length, 7 mm.

New South Wales: Mulwala (T. G. Sloane); unique.

An unusually distinct species. The scutellum is unusually large, and its clothing has a beautiful golden gloss; the abdomen and metasternum are almost glabrous, probably through abrasion. Seen directly from above the rostrum appears to be without ridges, and even from oblique directions these are not sharply defined. The elytral punctures are not in regular striae, as the elevations separating them in the rows are often on a level with the interstices; where not concealed by the clothing they are seen to be large, deep, and more or less quadrate, but some of them are much larger (two or three times the length) than the adjacent ones. As the two basal segments of the abdomen are feebly convex in the middle the type appears to be a female; the elytra are not mucronate, but there is a slight sutural notch.

DESIANTHA ALPINA, n. sp.

♀. Black. Closely covered with short, somewhat coppery setae, closely pressed to the derm.

Rostrum rather stout, slightly shorter than prothorax, with crowded punctures, with rather short lateral ridges only. Prothorax about as long as the basal width, sides strongly rounded; densely granulate-punctate, with a feeble median ridge. Elytra elongate-cordate, sides gently rounded, tips very feebly mucronate; with regular rows of fairly large punctures, interstices wide and flat, preapical callosities completely absent. Basal segment of abdomen slightly depressed in middle. Length, 8-10 mm.

New South Wales: Mount Kosciusko (B. Ingleby); Victoria: Alps (H. W. Davey).

An alpine species with scales completely absent and a rather curious rostrum. The seven specimens before me are structurally so much alike that I think they cannot belong to more than one species, but the setae differ in various forms, which may be thus noted:

Form 1 (typical).—A single coppery seta in each puncture not rising above the general level (except on parts of the rostrum and legs), on the elytra dense and very short, less than one-fifth as long as the interstice is wide, and so placed that, although not in even rows, they are from four to six deep across each interstice. From directly above, the rostrum appears to be entirely without ridges, even a faint median line not being indicated, but on each side there are two fine ridges extending parallel with a scrobe for about half its length. The seriate punctures on the elytra are sharply defined and scarcely one-third the width of the interstices, each contains a small setiferous granule.

Form 2.—Setae not quite as depressed as on the typical form (although on the elytra not rising above the general level), slightly longer and non-metallic; on the elytra they are somewhat dense (about eight to ten deep across each

interstice). The rostrum has a feeble shining median line (not at all elevated) from the interocular fovea almost to the apex, but the lateral ridges are less conspicuous than on Form 1.

Mount Kosciusko.

An almost completely abraded specimen (from the summit, W. E. Raymond) probably belongs to this form. Its interstices are seen to be densely and finely granulated, and the granules in the seriate punctures are very distinct.

Form 3.—Setae slightly longer, and sparser on the elytra than on Form 2, being placed from four to six deep, and some of them are almost half as long as an interstice is wide. The interstices themselves are distinctly separately convex. The rostrum has a feeble median line and the lateral ridges are very feeble.

Summit of Mount Kosciusko, in January (Dr. E. W. Ferguson).

The only male before me (taken by Mr. Ingleby) probably belongs to Form 3, as its elytral interstices are separately convex, but its elytral setae are intermediate between those of Forms 2 and 3. Its abdomen has a large shallow depression, common to the two basal segments.

DESIANTHA LONGA, n. sp.

Black; antennae and tarsi reddish, rest of legs darker (most of femora black). Densely clothed with rusty-brown or buff scales, obscurely variegated on elytra, the pronotum with three pale vittae, and a few sooty scales scattered singly; upper surface with rather sparse semi-erect setae; metasternum, abdomen and legs with white setae, but each femur with a subapical ring of metallic scales.

Rostrum moderately thin and curved, the length of sides of prothorax; with crowded punctures and remnants of five feeble ridges. Prothorax distinctly longer than wide, sides moderately rounded; with crowded normally concealed punctures. Elytra rather narrow but considerably wider than prothorax, oblong-cordate; striate-punctate, punctures partially concealed; preapical callosities rather feeble. Two basal segments of abdomen somewhat flattened in middle. Length, 7 mm.

Queensland: Cairns (E. Allen); unique.

A rather elongate species, in general appearance like some of the larger varieties of *D. maculata*, but rostrum with very feeble ridges instead of acute ones. In some lights some of the lateral scales have a greenish or coppery gloss. The type is probably a female, but its elytra are not at all mucronate.

DESIANTHA ALBIDOSPARSA, n. sp.

♂. Black; antennae and tarsi obscurely diluted with red. Clothed with white or whitish scales irregularly distributed; with white setae on under parts.

Rostrum of moderate length and evenly curved; with crowded punctures and seven ridges (of which four are indistinct). Prothorax slightly transverse, sides evenly rounded, base wider than apex, with crowded punctures and a feeble remnant of a median line. Elytra elongate-cordate; striate-punctate, punctures large and in places partially concealed, alternate interstices slightly elevated, preapical callosities very feeble. Abdomen with a rather shallow depression on two basal segments. Length, 6-7 mm.

♀. Differs in having the abdomen evenly convex and with somewhat shorter legs.

Queensland: Dalby (Mrs. F. H. Hobler).

Not very close to any previously described species, but perhaps nearest to *D. irrasa*, although much smaller, with different clothing and elytra. In some

lights, parts of the elytra appear to be obscurely reddish. There are some inconspicuous setae on the apical slope, but none on the rest of the upper surface; the elytra, owing to the irregular distribution of the scales, have a maculate appearance, on the pronotum remnants of three vittae are indicated. There are only three distinct ridges on the rostrum (the median one and one margining the scrobe on each side), but four others may be traced, or are indicated by rows of punctures.

DESIANTHA PUNCTICOLLIS, n. sp.

♂. Black; parts of antennae and of tarsi obscurely diluted with red. Rather densely clothed with short rusty-brown setae, closely applied to the derm and denser on the suture than elsewhere; under parts with fine white setae, the middle and hind tibiae fringed with white hairs.

Rostrum rather thin, moderately curved, shorter than prothorax, with crowded punctures and feeble ridges. Prothorax slightly longer than wide, sides strongly and evenly rounded, base and apex subequal; with crowded punctures separated by short longitudinal ridges. Elytra not much wider than widest part of prothorax, parallel-sided to beyond the middle; with regular rows of rather large punctures, alternate interstices somewhat elevated; without preapical callosities. Two basal segments of abdomen with a wide, shallow depression. Length, 7 mm.

Tasmania (Blackburn's collection); unique.

An isolated species, although with somewhat the appearance of a large *D. nigra*, from which it is at once distinguished by the rostrum and prothoracic punctures. The rostrum is not entirely without ridges, the median one being represented by a feeble basal remnant, and on each side two feeble ones may be traced for about half its length. On the pronotum the punctures appear to be all more or less longitudinally confluent owing to their sides being bounded by very fine ridges; this appearance is somewhat obscured by the clothing, but on close examination is sufficiently distinct.

DESIANTHA MUCRONATA, n. sp.

♀. Black; some parts obscurely diluted with red, antennae (club excepted) and tarsi reddish. Densely clothed with rusty-brown and slaty-white scales and setae, the pronotum trivirgate, the elytra maculate; under parts with white or whitish setae, the femora ringed.

Rostrum about the length of prothorax; with seven ridges, three acute and visible from above, the others lateral and less distinct. Prothorax slightly transverse, sides rather strongly rounded, base slightly wider than apex; with crowded, partially concealed punctures. Elytra considerably wider than prothorax, sides nowhere quite parallel, tips with strong diverging mucros; with rows of large partially concealed punctures, alternate interstices slightly elevated, preapical callosities slight. Two basal segments of abdomen slightly flattened in middle. Length, 5 mm.

South Australia: Lucindale (B. A. Feuerheerdt); unique.

In general appearance like *D. maculata*, but conspicuously tailed. To a certain extent it resembles *D. vittata*, but the elytra are not vittate, and the apical mucros are much longer, each being about the length of a claw joint. It is also allied to *D. caudata* and *D. nigra*, but the prothorax is somewhat shorter, the elytral mucros

are divergent instead of convergent or at least parallel, and the elytral setae are recurved and inconspicuous from above. The other species with mucronate elytra are larger and have the mucros much shorter and less conspicuous.

DESIANTHA PARVONIGRA, n. sp.

♂. Black; antennae (club excepted), tibiae, and tarsi red. Moderately clothed with obscurely variegated scales, mostly dark on the upper surface, pale on the sides of prothorax and on the under surface; elytra with a row of inconspicuous setae on each interstice; sterna densely squamose in parts, rest of under surface with fine white setae.

Rostrum almost the length of prothorax, with dense punctures, mostly in rows, with a shining but rather feeble median ridge and with remnants of others. Prothorax about as long as its greatest width, sides moderately rounded; with dense and rather small punctures. Elytra much wider than prothorax, parallel-sided to beyond the middle, with regular rows of large punctures, interstices not alternately elevated, preapical callosities feeble. Two basal segments of abdomen with a fairly deep elliptic impression, the apical segment with a median fovea. Length, 5 mm.

South Australia: Adelaide.

A small species, of which there are only males before me, but the females probably have mucronate elytra. In general appearance they are like males of *D. nigra*, but are smaller and with the rostrum differently sculptured. On a cotype male of that species the rostrum is distinctly seven-carinate, the median carina comparatively wide and shining, the others acute and sharply defined; on two other males and on several females the carinae are much the same; on the present species the median carina is rather feeble, and no others are distinct, but as the punctures are sublineate in arrangement several feeble ones on each side are indicated; the elytral setae are also less conspicuous.

DESIANTHA METALLICA, n. sp.

♂. Dark brown; antennae and legs red. Densely clothed with metallic green scales, becoming greyish and opaque on sides; with sparse, short, depressed, whitish setae.

Rostrum rather thin, curved, slightly longer than prothorax, with dense, normally concealed punctures and a feeble median line. Antennae long and thin. Prothorax about as long as its greatest width, sides moderately rounded; with crowded, concealed punctures. Elytra elongate, parallel-sided to beyond the middle, with rows of large partially concealed punctures, interstices not alternately elevated, preapical callosities scarcely indicated. Two basal segments of abdomen with a shallow median depression, the apical segment foveate. Legs long and thin. Length, 6-7 mm.

Victoria: Mallee (C. French Sen.).

A narrow species with beautiful clothing, unusually long legs and antennae, and rostrum with a feeble median line, which is continued backwards on to the head and base of prothorax. The eyes are more rounded than is usual, and the notch in front of the prosternum is unusually shallow. On a second specimen only the scales on the head and rostrum are green, the others being of a somewhat brassy-grey, but becoming opaque on the sides. I have also seen specimens from Swan Hill, in the collection of Mr. C. Oke.

DESIANTHA STENODERES, n. sp.

♀. Black; antennae, legs and part of abdomen reddish. Densely clothed with variegated scales and rather sparse curved setae; prosternum and sides of metasternum and of abdomen squamose, rest of under surface setose.

Rostrum slightly shorter than prothorax; with seven acute ridges, but the lateral ones partially obscured by clothing. Prothorax narrow, distinctly longer than wide, sides feebly rounded, base and apex equal; punctures normally concealed. Elytra much wider than prothorax, parallel-sided to near apex; with rows of large partially concealed punctures, alternate interstices very feebly elevated, preapical callosities moderately distinct. Two basal segments of abdomen slightly flattened in middle. Length, 3·5 mm.

Queensland: Cunnamulla (H. Hardcastle); unique.

A small, narrow, maculate species, smaller than any specimen I have seen of *D. maculata*, and rostrum with less conspicuous carinae; it is smaller even than *D. parva* and *D. pusilla*, and its clothing is very different. On the head and rostrum the scales are mostly rusty; on the pronotum they are also mostly rusty, but it has a trivirgate appearance; on the elytra the rusty scales are mostly confined to the suture base and sides, the rest of the surface being occupied by slaty-grey and sooty-brown spots irregularly mingled.

DESIANTHA PARVICORNIS, n. sp.

Black; antennae and most of legs reddish. Densely clothed with variegated scales, becoming whitish on parts of under surface; with rather sparse curved or oblique setae, very distinct from the sides.

Rostrum very feebly curved, scarcely the length of prothorax, ridges feeble, or at least scarcely traceable through clothing. Antennae unusually short. Prothorax almost as long as wide, sides moderately rounded; punctures normally concealed. Elytra parallel-sided to beyond the middle, with rows of large partially concealed punctures, interstices not alternately elevated. Two basal segments of abdomen strongly convex, but slightly flattened in middle. Length, 3·5 mm.

Victoria: Sea Lake (J. C. Goudie); unique.

About the size of the preceding species, but with a somewhat rougher appearance and with shorter antennae (shorter than in any other known species of the genus); a character at once distinctive from *D. parva* and *D. pusilla*. They are about the length of those of *Anorthorhinus brevicornis*, but are slightly thinner. The scales are mostly rusty-brown, and are larger than usual, the pronotum is faintly trivittate, on the elytra there are paler and darker spots, but they are nowhere sharply defined. The preapical callosities are indicated by pale spots, otherwise they would be scarcely evident.

DESIANTHA LATA, n. sp.

Black; antennae (club excepted) and tarsi reddish. Densely clothed with pale muddy-grey scales, on the upper surface variegated with sooty or sooty-brown, a distinct whitish spot on the second and third interstices on each elytron, slightly beyond the middle.

Rostrum rather stout and evenly curved, punctures normally concealed except about apex. Prothorax distinctly transverse, sides moderately rounded, base and apex equal; punctures normally concealed. Elytra wide, oblong-cordate; striate-punctate, but punctures normally entirely concealed. Two basal segments of

abdomen gently depressed in middle. Femora stout, tibiae acutely denticulate. Length, 4 mm.

New South Wales: Windsor, in flood debris (A. M. Lea); unique.

A small, wide, densely squamose species, with the general appearance of *D. malevolens*, but considerably wider, the postmedian spot on each elytron not confined to the third interstice, and each tibia with a much longer fringe of silken hairs. On the pronotum there is a wide vitta of sooty scales on each side of a pale median line; on the elytra the sooty scales are most numerous near the suture, the paler ones near the sides; on the upper surface there are but few setae and they are inconspicuous even from the sides.

Desiantha rostralis, n. sp.

Black; antennae and tarsi reddish. Densely clothed with muddy-grey scales, obscurely variegated with paler and darker ones, an obscurely pale spot on the second and third interstices on each elytron, slightly beyond the middle.

Rostrum stout, suddenly and strongly bent downwards near base, punctures concealed except at tip, ridges apparently absent. Prothorax distinctly transverse, sides evenly rounded, base and apex equal; with crowded concealed punctures. Elytra scarcely one-fourth wider than prothorax, oblong-cordate; striate-punctate, striae distinct, the punctures large but normally quite concealed, interstices regular, without preapical callosities. Basal segment of abdomen depressed in middle. Length, 4 mm.

New South Wales: Windsor, in flood debris (H. J. Carter).

With the general appearance of *D. malevolens*, but rostrum very different; its base is almost on an even plane with the head, but at about the basal third is abruptly turned downwards; on *malevolens* the rostrum and front part of the head have an almost even incurvature. Seen from the sides the differences are very conspicuous. There are some setae on the upper surface, but as they are pressed flat amongst the scales (except a few on the apical slope) they are inconspicuous, even from the sides. On the type four irregular sooty vittae or series of spots may be traced on the pronotum; the elytra have a feebly spotted appearance, the dark scales being more abundant near the suture than elsewhere. On a second specimen the clothing is almost uniformly muddy-grey or pale brown, not much paler on the under surface than on the prothorax and elytra.

Cydmaea crassirostris Blackb.

The type of this species was unique and is now in the British Museum. Numerous specimens now before me from New South Wales (Mittagong and Sydney), Victoria, Tasmania (Avoca) and South Australia (Mount Lofty), appear to belong to it. The clothing is somewhat variable, but on the elytra may be considered to be in four main divisions: 1, A large, sharply limited, subtriangular pale patch on the apical slope; 2 and 3, A large triangular black patch on each side, but each patch with numerous irregularly distributed pale spots; 4, A less sharply defined pale basal triangle, connected along the suture with the apical one. On the pronotum there are usually three ill-defined dark vittae. On the head there are usually three dark spots, usually isolated, but occasionally connected so as to enclose the pale spots; the scales between the eyes and base of rostum vary from almost white to brilliant golden-red. The inflation of the rostrum, as seen from the sides, is scarcely evident in the female.

CYDMAEA INVALIDA Blackb.

Although only one specimen was mentioned in the original description there are two in the South Australian Museum marked as cotypes, from the original locality (Petersburg, in South Australia). Other specimens are from Melrose, Murray Bridge, Parachilna, Hergott and Barossa. The scales are opaque (a character not previously mentioned, but of importance in the genus); the pronotum has a large but usually not solid median patch of muddy-brown scales, and numerous irregularly distributed spots of similar scales on the elytra.

CYDMAEA GRISEA Lea.

Two specimens received many years ago, from the Australian Museum, as coming from Queensland, possibly belong to this species; they differ from the type (from the Swan River), in having the markings (three feeble prothoracic vittae and numerous elytral spots) more conspicuous. In general appearance they are like large specimens of *C. diversa*, but a larger percentage of the clothing of the upper surface is pale, and the rostrum is somewhat longer and stouter. The two basal segments of abdomen are flattened in the middle, so they are probably males; the types, which have those segments gently convex, are probably females.

CYDMAEA NASALIS, n. sp.

♂. Black; apical third of rostrum, antennae, tibiae and tarsi reddish. Densely clothed with whitish and brownish scales, obscurely mingled on upper surface, but each elytron with a large round median blackish spot; under surface with silvery-white scales, with a metallic gloss on sides.

Rostrum strongly and evenly curved, slightly longer than prothorax and scutellum combined, with fine ridges alternated with rows of squamiferous punctures almost to apical third (where the antennae are inserted), in front with rather dense and small but sharply defined punctures. Prothorax slightly diminishing in width from base to near apex, and then suddenly to apex itself, which is only half the width of base; with crowded normally concealed punctures. Elytra oblong-cordate; with rows of large punctures, appearing much smaller through clothing. Two basal segments of abdomen gently depressed in middle. Front coxae touching. Length, 4 mm.

♀. Differs in having the rostrum somewhat longer and thinner, more of it reddish, ridges and seriate punctures scarcely extending to middle, antennae inserted less close to apex, and abdomen evenly convex.

South Australia: Gawler (A. M. Lea).

A bimaculate species and from Gawler, the original locality of *C. bimaculata*, but differs from that species in being larger, and in having the rostrum considerably longer (even in the male it is distinctly longer than the prothorax) and partly reddish. A South Australian (Nuriootpa) specimen agrees well with the description of *bimaculata*, and three from New South Wales were so identified by Blackburn, and the differences are constant.

CYDMAEA INTERMIXTA, n. sp.

Black; antennae, tibiae and tarsi reddish. Densely clothed with variegated scales, the under parts with silvery-white ones, with a slight bluish or coppery gloss on sides.

Rostrum moderately and evenly curved, with fine ridges alternated with rows of punctures (squamiferous near base) to insertion of antennae (at apical two-

fifths). Prothorax with sides rather strongly rounded but much wider at base than at apex; with crowded normally concealed punctures. Elytra oblong-cordate; seriate punctures obscured by clothing; alternate interstices feebly elevated, with a feeble preapical callus at the junction of the fourth and sixth on each side. Front coxae almost touching. Length, 2·5-3·0 mm.

Western Australia: Swan River (A. M. Lea).

Structurally close to *C. dorsalis*, but with very different clothing. In its general appearance it resembles *C. major* on a greatly reduced scale. The clothing of the upper surface is irregularly intermingled, and varies from a bluish-white, through buff and ochreous, to dark brown (almost black); on the pronotum there is usually a fairly large ill-defined brown patch, with a whitish patch on each side of the base; on the middle of the side of each elytron there is a subtriangular white patch, preceded and followed by dark brown ones; on the head the scales are mostly pale brown, often with a coppery gloss, with three ill-defined dark spots. In certain lights many of the paler scales on the sides, as well as on the under parts, appear brilliantly metallic. The sexes are not very sharply defined, the male has a slightly shorter and stouter rostrum than the female, with seriate punctures in slightly longer rows, and the two basal segments of its abdomen are feebly depressed in the middle, instead of evenly convex.

CYDMAEA BASALIS, n. sp.

Black; tip of rostrum, funicle, club, and parts of legs obscurely reddish, scape paler. Densely clothed with opaque whitish and mouse-coloured scales on upper surface, white with a greenish or bluish gloss on under parts.

Rostrum about the length of prothorax, strongly arched at base, almost straight in front; apical half with small, sharply defined punctures, basal half with stronger concealed ones. Antennae inserted about two-fifths from apex of rostrum. Prothorax distinctly transverse, sides rather strongly rounded, apex about two-thirds the width of base; with crowded concealed punctures. Elytra oblong-cordate, not much wider than prothorax, striate-punctate, but punctures normally concealed. Abdomen rather strongly convex, apex with a small open depression. Front coxae slightly separated. Length, 2·5 mm.

Victoria: Birchip and Sea Lake (J. C. Goudie, No. 191).

The opaque clothing of the upper surface is almost of the same shades of colour as on *C. invalida*, but is differently disposed; its rostrum is also considerably stouter than on that species, at first it appears to be of a shining black, but its apex is really obscurely diluted with red. In general appearance it is fairly close to *C. cryptoderma*, but the dark clothing of the upper surface is darker and the rostrum is wider, suddenly curved at the base and mostly black. The dark scales cover most of the pronotum, but appear slightly vittate; on the elytra they also cover most of the surface, the whitish scales prevailing at the base and along the suture to beyond the middle, where they join a feeble transverse fascia, so that they form a wide H (sideways); in addition there are some pale scales on the tips and sides; on the head and base of rostrum most of the scales are dark, but on the latter, in some lights, they have a golden or brassy lustre. The four specimens taken, judging by the abdomen, appear to be females.

CYDMAEA SORDIDA, n. sp.

Black; apical third of rostrum and parts of legs obscurely reddish, antennae paler. Densely clothed with opaque scales on upper surface, silvery-white with a rosy gloss on under surface.

Rostrum about the length of prothorax, strongly arched at base; with fine ridges alternated with rows of squamiferous punctures to apical third (where the antennae are inserted), in front with numerous small, sharply defined punctures. Prothorax with sides rather strongly rounded, apex slightly more than half the width of base; with dense, normally concealed punctures. Elytra oblong-cordate, not much wider than prothorax; striate-punctate, striae appearing narrow and regular through clothing, the punctures large but concealed. Front coxae touching. Length, 3 mm.

Western Australia: Ankertell (H. W. Brown); unique.

Larger than *C. opaca*, and the other species with opaque clothing on the upper surface. The rostrum is almost as strongly arched at the base as on the preceding species, and its apex is obscurely diluted with red. The scales on the upper surface are mostly of a pale slaty-brown, with a large dark patch (obscurely defined) on each elytron, and some obscure whitish spots, but on the sides of both prothorax and elytra white scales are very distinct; on the base of the rostrum the scales in some lights appear metallic. On the under parts the scales are white but in some lights with a conspicuous rosy or golden-red gloss, except on the three apical segments, which, owing to sparsity of clothing, appear black, in sharp contrast with the preceding ones; the latter are flattened or faintly depressed in the middle, so that the type is probably a male.

CYDMAEA LATIROSTRIS, n. sp.

♂. Black; densely clothed with sooty-brown scales, the pronotum with a feeble greyish median line, the elytra with numerous small, greyish spots and a small grey V, about the scutellum; under parts with silvery-grey scales.

Rostrum about the length of prothorax, moderately curved, rather stout and feebly dilated to apex; with fine ridges, alternated with rows of squamiferous punctures to apical third (where the antennae are inserted), in front with crowded and comparatively large ones. Prothorax almost as long as wide, sides strongly and evenly rounded, base very little wider than apex; punctures normally concealed. Elytra cordate, shoulders strongly rounded, near base considerably wider than base of prothorax; striate-punctate, but punctures normally concealed. Abdomen with a shallow depression on basal segment, third and fourth combined slightly longer than second or fifth. Legs rather stout, front coxae touching. Length, 3 mm.

Queensland: Cairns district (F. P. Dodd); unique.

A somewhat aberrant member of the genus, with the rostrum dilated to the tip, and the prosternal notch deeper than usual; the scape is also shorter and stouter than usual, and its seventh joint is so closely applied to the club that at first glance it appears to belong to it. The abdominal scales in some lights have a faint greenish gloss.

CYDMAEA LEUCOMELA, n. sp.

Black; apical third of rostrum, antennae and tarsi more or less reddish. Densely clothed with black and white scales on upper surface, white with a slight greenish gloss on under parts.

Rostrum rather thin, moderately curved, scarcely longer than prothorax; with fine ridges alternated with rows of squamiferous punctures to apical third (where the antennae are inserted), in front with small distinct punctures. Prothorax with sides strongly rounded, apex about three-fifths the width of base; punctures dense

and normally concealed. Elytra oblong-cordate, not much wider than base of prothorax; striate-punctate, striae narrow and punctures normally concealed. Front coxae touching. Length 2·5 mm.

Western Australia: Swan River (A. M. Lea); unique.

A conspicuously marked species. On the pronotum the white scales form a narrow vitta on each side and some small spots in the middle; on the elytra the suture is narrowly white throughout, the three following interstices on each side are black, except at the tips, then white sublineate spots are numerous to the margins. The funicle is somewhat darker than the other parts of the antennae, which are conspicuously reddish. The two basal segments of the abdomen are flattened in the middle, and the antennae are inserted at the apical third of the rostrum, so the type appears to be a male.

Cydmaea vitticollis, n. sp.

Black; densely clothed with black and white scales on upper surface, white with a faint metallic gloss on under parts.

Rostrum slightly longer than prothorax, thin, and (for the genus) rather lightly curved, with fine ridges alternated with rows of squamiferous punctures to apical third (where the antennae are inserted), in front with small sharply defined punctures. Prothorax almost as long as the median width, sides rather strongly rounded, base very little wider than apex, punctures dense and normally concealed. Elytra oblong-cordate, considerably wider than prothorax; striate-punctate, punctures almost concealed. Front coxae touching. Length, 2·5 mm.

South Australia: Mount Lofty Ranges (S. H. Curnow and A. M. Lea).

The scales on the upper surface are much as those on *C. diversa*, except that on the prothorax they are differently arranged, but the prothorax itself on that species is less rounded, with the base considerably wider than the apex. On the pronotum of the present species the white scales form a narrow median vitta and a semi-double irregular one on each side; on the elytra they form numerous irregularly distributed spots, with a tendency to a sublineate arrangement; the suture is black almost throughout. The median ridge of the rostrum is narrow, shining, and more distinct than is usual. As the basal segment of the abdomen is feebly concave on the four specimens taken they are probably all males.

Cydmaea inconstans, n. sp.

♀. Black; densely clothed with whitish and slaty-grey scales on upper surface, silvery-white with a slight rosy or greenish gloss on under parts.

Rostrum long (slightly longer than prothorax and scutellum combined), thin and moderately curved, with fine ridges alternated with rows of punctures (squamiferous near base) to middle (where the antennae are inserted), in front with minute punctures. Prothorax with sides rather strongly rounded and widest at base, which is almost twice the width of apex; with dense partially concealed punctures. Elytra cordate, widest at about basal fourth; striate-punctate, punctures not entirely concealed. Abdomen evenly convex. Front coxae touching. Length, 3 mm.

Tasmania: Hobart (A. M. Lea).

In general appearance the type is like an unusually large pale specimen of *C. diversa*, but the prothorax is not quite as wide at the base, and the rostrum is unusually long and thin. From *C. grisea* it is distinct by its longer, thinner, and entirely black rostrum. At first glance the clothing on its upper surface appears

to be entirely whitish, but on close examination a feeble slaty-grey median vitta may be seen on the pronotum and numerous small indistinct spots on the elytra; on each interstice of the latter the scales are in two rows, separated by setae, but the setae are scarcely visible even from the sides; on many other species, however, double rows of scales may be traced on the elytra.

A female from New South Wales (Blue Mountains, Dr. E. W. Ferguson) evidently belongs to this species, but its dark scales are confined to a wide and feeble vitta extending from the middle of pronotum almost to the apex of elytra. Another from Western Australia (Swan River, A. M. Lea), probably also belongs to the species, but its antennae and tarsi are more or less obscurely reddish, and the clothing of its upper surface is entirely bluish-white, except for some scales scattered singly. One from the Blackburn collection, without a locality label, and minus its antennae, probably also belongs to the species; the clothing of its upper surface is almost stramineous, with a slight metallic gloss, but there are some very feeble darker opaque spots; in certain lights the clothing of its under surface is brilliantly opalescent, but from most directions it has a rosy gloss. It appears to be a male, as the basal segments of its abdomen are flattened or feebly concave in the middle, and the punctures on the apical half of its rostrum are more distinct.

CYDMAEA SUBUNIFORMIS, n. sp.

Black; antennae distinctly reddish. Densely clothed with whitish scales, obscurely variegated with somewhat darker ones on upper surface; on under parts silvery-white, with a greenish or rosy gloss.

Rostrum thin and (for the genus) rather feebly curved, scarcely the length of prothorax, with fine ridges alternated with rows of squamiferous punctures on basal third. Antennae inserted about middle of rostrum. Prothorax about as long as the median width, sides evenly rounded, base scarcely one-fourth wider than apex; punctures dense and mostly concealed. Elytra oblong-cordate, conspicuously wider than prothorax, with narrow striae containing large but almost concealed punctures. Basal segment of abdomen gently convex. Front coxae touching. Length, 2 mm.

New South Wales: National Park (A. M. Lea).

Approaching *C. diversa*, but prothorax distinctly narrower at base and scales of upper surface nowhere sharply contrasted, and with the paler ones in the majority. It is also like the preceding species on a reduced scale, with the rostrum almost as thin but distinctly shorter, and the prothorax narrower at the base. The type is probably a female.

CYDMAEA MULTIMACULATA, n. sp.

Black; scape reddish, rest of antennae and claw-joints darker, but not black. Densely clothed with stramineous scales, with numerous chocolate-brown spots on upper surface, silvery-white with a slight metallic gloss on under parts.

Rostrum rather thin, moderately curved, the length of prothorax, with fine ridges alternated with rows of squamiferous punctures to apical third (where the antennae are inserted), in front with numerous small but distinct punctures. Prothorax about as long as wide, sides feebly decreasing in width from base to near apex, and then rather suddenly to apex itself, which is about two-thirds the width of base; punctures entirely concealed. Elytra cordate, not much wider than

prothorax; with series of partly concealed punctures in distinct striae. Basal segments of abdomen evenly convex. Front coxae touching. Length, 2·5 mm.

South Australia (Macleay Museum).

Fairly close to *C. diversa*, but the pale scales of the upper surface are in the majority, and the pronotum has four conspicuous dark spots, which are somewhat angular and placed two in the middle and two behind them at the base; there are numerous spots on the elytra; on the basal third mostly free, on the median third mostly irregularly conjoined (subfasciate at the summit of the apical slope), and sparse on the apical third. The stramineous scales from most directions seem opaque, but from others have a distinct silvery lustre. Judging by the abdomen the type appears to be a male, but the sculpture of the rostrum and the insertion of antennae render this doubtful.

Cydmaea monobia, n. sp.

♀. Black; antennae obscurely reddish. Densely clothed with white and black scales on upper surface, silvery-white, with a rosy or greenish gloss on under parts.

Rostrum moderately thin and curved, the length of prothorax, with fine ridges alternated with rows of punctures (squamiferous near base) to middle (where the antennae are inserted), in front with small but fairly distinct punctures. Prothorax as long as wide, sides evenly rounded and not much wider at base than at apex; punctures dense and mostly concealed. Elytra elongate-cordate, with fairly large, partly concealed punctures, in narrow striae. Two basal segments of abdomen strongly convex. Front coxae touching. Length, 2 mm.

North Australia: Roper River (N. B. Tindale); unique.

Allied to *C. diversa*, but distinctly narrower, and with elytral clothing mostly white, with a few small black spots, but the black scales are mostly scattered singly, causing the surface to appear speckled rather than maculate; on the pronotum, however, there is a fairly conspicuous median vitta. The type is the only specimen of the genus I have seen from North Australia.

Cydmaea indistincta, n. sp.

Black; antennae and legs distinctly reddish. Densely clothed with whitish and blackish scales on upper surface, the whitish ones with a more or less distinct metallic gloss, the blackish ones opaque; under parts with silvery-white scales with a faint rosy or greenish gloss.

Rostrum thin, moderately curved and the length of prothorax, with fine ridges alternated with rows of punctures (squamiferous on basal fourth) to middle (where the antennae are inserted), in front with small punctures. Prothorax with sides rounded and increasing in width to base, which is almost twice the width of apex; with crowded concealed punctures. Elytra oblong-cordate; with fairly large, partially concealed punctures, in narrow striae. Basal segments of abdomen moderately convex. Front coxae touching. Length, 2 mm.

Western Australia: Swan River (A. M. Lea).

In general appearance like small *C. diversa*, but with red legs. The type has a fairly distinct dark median vitta and some small spots on the sides of the pronotum; on the elytra the whitish scales are less abundant than the darker ones, and are condensed into numerous small irregular spots, and an irregular fascia across the summit of the apical slope. On a second specimen the paler scales are

more numerous and the spotted appearance is less evident. A third one is probably immature as its derm is entirely of a dingy red, not much darker than the legs. They appear to be all females.

CYDMAEA EXILIS, n. sp.

♂. Black; antennae blackish. Densely clothed with variegated scales on upper surface, silvery-white with a golden or greenish gloss on under parts.

Rostrum thin, moderately curved, and slightly longer than prothorax; with fine ridges, alternated with rows of squamiferous punctures to two-fifths from apex (where the antennae are inserted), in front with small but fairly distinct punctures. Prothorax about as long as its greatest width, sides evenly rounded and very little wider at base than at apex; with crowded, concealed punctures. Elytra comparatively long, oblong-cordate, notably wider than prothorax, with large, partly concealed punctures in narrow striae. Basal segment of abdomen depressed in middle. Front femora touching. Length, 2 mm.

Victoria: Carrum (C. Oke), Cheltenham (H. W. Davey).

On the type, the scales on the head are mostly white, with a golden gloss; on the pronotum whitish scales (in some lights with a golden gloss) form a median line, and are dense on the sides, the interspaces having black scales; on the elytra there is a short black fascia crowning the apical slope, preceded and followed by irregular white ones; there is a fairly large transverse patch of blackish scales about the middle, elsewhere the scales are mostly whitish, but often with a metallic gloss, brilliantly golden in some lights. On a second specimen, from Carrum, the scales on the upper surface are less metallic and the fasciae are less evident. On two specimens, from Cheltenham, the golden gloss is less evident than on the type, on one of them the white postmedian fascia is irregularly connected with the shoulders by white spots, so as to resemble an irregular U, on the type and the other specimens this is less evident, but they all have the median vitta of the pronotum distinct. A male, from New South Wales (Sydney, A. M. Lea) probably belongs to this species, but may be immature; it is of a dull piceous-brown, with the suture and most of the under surface black. The clothing of the pronotum is as on the type, but the fasciae of the elytra are less pronounced.

On this and the next species the general outlines are much as those of *Eniopea*, but the elytra are without the two small nodules that are usually present on the species of that genus; they are comparatively narrow species, the prothorax with evenly rounded sides, and base and apex almost equal.

CYDMAEA SOROR, n. sp.

♂. Black; legs and antennae blackish. Densely clothed with white or whitish scales, feebly variegated with pale slaty-grey on the upper surface.

Sculpture as described in the preceding species. Length, 2 mm.

♀. Differs in having the two basal segments of abdomen strongly convex, the rostrum slightly longer and thinner, with smaller punctures and antennae inserted slightly more distant from apex.

Queensland: Blackall Ranges (H. Hacker).

Structurally as the preceding species, but clothing of upper surface almost uniform, both in colour and disposition, although on close examination faintly darker markings may be seen.

CYDMAEA RUFICORNIS, n. sp.

♂. Black; antennae pale reddish, the club slightly darker than the other parts. Rather densely clothed with whitish scales, feebly variegated on upper surface; elytra, in addition, with a row of whitish setae on each interstice.

Rostrum moderately thin and curved, with fine ridges alternated with rows of squamiferous punctures on basal half, elsewhere with naked ones. Antennae inserted two-fifths from apex of rostrum. Prothorax moderately transverse, sides evenly rounded and distinctly wider at base than at apex; with crowded, partially concealed punctures. Elytra cordate, not much wider than prothorax; with rows of large, partially concealed punctures in regular striae. Two basal segments of abdomen flattened in middle. Front coxae touching. Length, 1·75 mm.

♀. Differs in having the basal segments of abdomen strongly convex, rostrum longer, thinner, with ridges and seriate punctures shorter, and clothed only near base.

Western Australia.

A small species, with pale antennae and almost uniform clothing; on close examination the scales appear to be feebly variegated, but this is due quite as much to slightly different densities, as to shades of colour. The elytral setae are not very long, but are fairly distinct from the sides.

CYDMAEA SCUTELLARIS, n. sp.

♂. Bright reddish-castaneous; scutellum black. Moderately clothed with white scales, variegated with dark ones on upper surface.

Rostrum not very thin, moderately curved, parallel-sided, the length of prothorax, with fine ridges alternated with rows of punctures (squamiferous on basal third) to apical third (where the antennae are inserted), in front with minute punctures. Prothorax distinctly transverse, sides almost evenly rounded but base one-third wider than apex; with crowded, partially concealed punctures. Elytra oblong-cordate, not much wider than prothorax; with rows of rather large, partially concealed punctures, in rather narrow striae. Two basal segments of abdomen depressed in middle. Front coxae almost touching. Length, 2 mm.

♀. Differs in having the abdomen evenly convex, and the rostrum slightly longer with shorter ridges and seriate rows of punctures.

South Australia: Lucindale (B. A. Feuerheerdt).

In general appearance like a small *Dicomada*, but the notch at the apex of the prosternum is well defined. The scutellum appears as a small black spot. Most of the scales on the upper surface are white, but in places they are sparser than elsewhere, giving the surface a slightly variegated appearance, but there are really some darker scales, which are condensed to form a rather wide and irregular antemedian fascia on the elytra, and a smaller and still less regular postmedian one, there are also some dark scales on the shoulders.

CYDMAEA CORDIPENNIS, n. sp.

Black; antennae obscurely reddish. Densely clothed with variegated scales.

Rostrum moderately thin and curved, very little longer than prothorax, with fine ridges alternated with rows of punctures (squamiferous near base) to apical third (where the antennae are inserted), in front with rather dense and small but sharply defined ones. Prothorax moderately transverse, sides evenly rounded, base about one-third wider than apex; with crowded, normally concealed punctures.

Elytra cordate, widest at about basal fifth; striate-punctate. Front coxae touching. Length, 2·5-3·0 mm.

South Australia: Port Lincoln (A. M. Lea), Lucindale (B. A. Feuerheerdt), Gawler (J. Faust).

Allied to *C. diversa*, but the average size is slightly larger, and the elytra have a conspicuous postmedian fascia. It is also apparently allied to *C. cara*, but the rostrum and legs are entirely black. The clothing on the upper surface of the Port Lincoln specimens varies considerably; on the head the scales are white and blackish, but sometimes the pale ones have a golden gloss; on the pronotum there is usually a dark median vitta, and a white spot on each side of the base, elsewhere the scales being irregularly mingled; on some specimens, in certain lights, some of the scales are brilliantly golden, but on others they are all opaque; on the elytra white, chocolate-brown and sooty scales are irregularly mingled, except that the white fascia is conspicuous; on the under surface the scales are silvery-white, with a greenish gloss, but on the apical segment they are sometimes black. On two males from Lucindale there is a dark median vitta and two dark spots on each side of the pronotum, the rest of its scales, and those on the head and on the elytral suture are of an almost golden-red. On the specimen from Gawler, all the scales on the upper surface are opaque. On specimens in good condition the elytra appear to be finely striated only, but on abrasion the striae are seen to be moderately wide, and to contain rather large and deep punctures, and the interstices to be densely and finely punctate. The sexual differences are not very pronounced, the male having the abdomen less convex, and the rostrum slightly shorter than in the female.

Cydmaea aemula, n. sp.

♂. Black; antennae obscurely reddish. Densely clothed with white and black scales on upper surface, white on under parts.

Rostrum moderately thin and curved, the length of prothorax, with fine ridges alternated with rows of punctures (squamiferous on basal fourth) to insertion of antennae (slightly in advance of the middle), in front with small but sharply defined punctures. Prothorax moderately transverse, sides evenly rounded, base about one-fourth wider than apex; punctures dense and normally concealed. Elytra cordate, not much wider than prothorax, and widest at basal third; striate-punctate. Basal segments of abdomen flattened in middle. Front coxae touching. Length, 2 mm.

New South Wales: National Park (A. M. Lea); Sydney.

With the black and white scales of *C. diversa*, but a narrower species and with a white fascia crowning the apical slope. From the preceding species it differs in being smaller and narrower, and the fascia less pronounced. The dark scales form a feeble median vitta and some spots on the pronotum, on the elytra they are irregularly mingled with the white ones and are more numerous before and behind the rather feeble white postmedian fascia. In some lights an occasional scale on the under surface appears brilliantly golden or green.

Cydmaea metasternalis, n. sp.

♂. Black; antennae blackish, but base of scape reddish. Densely clothed with black scales and setae on upper surface, marked with whitish slightly metallic spots, on under surface with white and greenish scales, becoming brilliantly green on metasternum.

Rostrum rather thin, moderately curved, scarcely longer than prothorax, with fine ridges alternated with rows of squamiferous punctures to insertion of antennae (slightly nearer apex than base) in front with small, sharply defined punctures. Prothorax slightly transverse, sides rather strongly rounded in middle, base slightly wider than apex, punctures normally concealed. Elytra cordate, not much wider than prothorax; with rather large, partially concealed punctures, in striae. Basal segment of abdomen feebly depressed along middle. Front coxae slightly separated. Length, 2 mm.

Queensland: Cairns district (A. M. Lea); unique.

A beautiful species, in some respects approaching *C. luctuosa*, but scales of metasternum of a brilliant emerald-green, and elytra with black sloping setae, very conspicuous from the sides, and from behind seen to be placed in a single row on each interstice. The white scales on the upper surface (appearing coppery or greenish in certain lights) are condensed into a fairly large spot on each side of base of prothorax, some smaller ones on the basal half of elytra, and into remnants of a narrow postmedian fascia, with a few scattered singly. The tarsi are missing from the type.

Cydmaea viridis, n. sp.

♂. Black; antennae and apical half of rostrum reddish, tarsi somewhat darker. Densely clothed with green or coppery-green scales. With pale, suberect setae, on the elytra formed into a single row on each interstice.

Rostrum rather thin, moderately curved, slightly longer than prothorax; with fine ridges, alternated with rows of squamiferous punctures on basal half, with small punctures in front. Antennae inserted about two-fifths from apex of rostrum. Prothorax almost as long as wide, sides evenly rounded and about one-fourth wider at base than at apex; punctures normally concealed. Elytra cordate, not much wider than prothorax; appearing narrowly striate, with rows of punctures concealed. Basal segments of abdomen feebly depressed along middle; front of prosternum feebly grooved along middle, and rather feebly notched in front, with the front coxae slightly separated. Length, 1·75 mm.

♀. Differs in having the rostrum slightly longer and thinner, more of its apex red, less of its base squamose, and basal segments of abdomen evenly convex.

Queensland: Gayndah (A. M. Lea).

Very distinct by its green scales and suberect setae. *C. viridula* is a larger species, with inconspicuous setae and normal prosternum. The faint pectoral canal and slight separation of the front coxae are insufficient for the species to be considered to belong to the Cryptorhynchides.

Cydmaea murina, n. sp.

Black; apical half of rostrum and antennae reddish, parts of legs somewhat darker. Densely clothed with mouse-coloured scales variegated with white on upper surface, white on under parts. With numerous sub-erect setae, on the elytra placed in a single row on each interstice. Length, 1·5 mm.

Queensland: Gayndah (A. M. Lea); unique.

Structurally as in the preceding species, including the slightly grooved prosternum and separated front coxae, but the clothing of the upper surface is opaque, and without the least tinge of green. The mouse-coloured scales are variegated with white on the sides of prothorax and base of elytra, with a few

inconspicuous spots elsewhere; on the under surface, from certain points of view, some of the scales have a rosy or greenish gloss.

CYDMAEA SETIPENNIS, n. sp.

Black; antennae reddish, parts of legs somewhat darker. Densely clothed with chocolate-brown scales, variegated with whitish or coppery-white ones, becoming white with a slight greenish gloss on under parts. With short, sloping setae, on the elytra condensed into a single row on each interstice, and fairly distinct from the sides.

Rostrum moderately thin, evenly curved, about the length of the prothorax; with fine ridges alternated with rows of squamiferous punctures on basal half, elsewhere with small punctures. Antennae inserted slightly nearer apex than base of rostrum. Prothorax moderately transverse, sides almost evenly rounded, base not much wider than apex; punctures dense and normally concealed. Elytra cordate, widest at about basal fourth; with rather large punctures in striae, partially concealed by clothing. Basal segments of abdomen gently flattened in middle. Front coxae touching. Length, 1·75 mm.

Queensland: Cairns district (A. M. Lea); unique.

A small species, with fasciate and setose elytra. On the head (except for an opaque median spot) and base of rostrum the scales, from some directions, appear brilliantly golden; on the pronotum the chocolate ones form a fairly wide median vitta and some lateral spots; on the elytra they are the prevailing ones, the paler scales forming irregular spots on and about the shoulders, and an irregular post-median fascia. The type is probably a male.

CYDMAEA INTEROCULARIS, n. sp.

♂. Black; antennae and tarsi somewhat darker. Densely clothed with dark slaty-grey scales mixed with whitish ones on upper surface, white with a slight greenish gloss on under parts. With numerous semierect and usually dark setae, on the elytra confined to a single row on each interstice.

Rostrum moderately thin and curved, the length of prothorax, with fine ridges alternated with rows of squamiferous punctures to apical third (where the antennae are inserted), in front with small punctures. Prothorax distinctly transverse, sides gently rounded, base about one-fourth wider than apex; punctures dense and normally concealed. Elytra briefly oblong-cordate, striate-punctate. Basal segments of abdomen slightly flattened in middle. Front coxae touching. Length, 1·6 mm.

Queensland: Blackall Ranges (A. M. Lea); unique.

Another small setose species, but distinguished from the preceding one by being more robust, with the dark median part of the pronotum extending almost to the sides, instead of separated therefrom by a narrow vitta near each side. On the head the pale scales are very numerous, and they form a conspicuous spot between the eyes, on the pronotum they are confined to the sides, but each side has also a dark spot; on the elytra they are irregularly distributed in small spots, sometimes conjoined to form feeble fasciae, of which there is a very irregular bisinuate one crowning the apical slope. The scales on the metasternal episterna in some lights appear brightly green, and there may appear quite a brilliant green spot on the front of each front coxa. The elytral setae are very distinct from the sides; they divide the scales on each interstice into two rows, and these are so

placed that the punctures in the striae are normally concealed, and the striae themselves appear to be doubled.

CYDMAEA GEMMEA, n. sp.

♂. Black; antennae reddish. Densely clothed with black scales interspersed with white ones with a greenish or golden gloss; under parts with white scales with a distinct greenish gloss in certain lights. With numerous suberect black setae, on the elytra confined to a single row on each interstice.

Rostrum rather thin, evenly curved, the length of prothorax; with fine ridges alternated with rows of squamiferous punctures on basal half, elsewhere with naked punctures. Antennae inserted two-fifths from apex of rostrum. Prothorax distinctly transverse, sides almost evenly rounded, base scarcely one-fourth wider than apex; with dense, partially concealed punctures. Elytra cordate, base not much and not suddenly wider than prothorax; striate-punctate, punctures large but partially concealed. Two basal segments of abdomen feebly depressed along middle. Front coxae touching. Length, 1·5 mm.

Queensland: Cairns district, attracted to lights (A. M. Lea), Bellenden-Ker (Dr. E. Mjöberg).

A small setose species, with brilliant scales scattered singly; on the type a few are compacted together on the suture; on the second specimen there is a small patch on each side of the base of the prothorax. The scales on the metasternal episterna are denser than elsewhere, in some lights they appear of an opaque white, but in others of a bright green. The elytral setae are very distinct from the sides. The scape is the palest part of the antennae. A female, of which the prothorax was lost, has the rostrum longer and thinner, clothed only close to base, and with the abdomen strongly convex.

NOTES ON FOUR LITTLE-KNOWN SPECIES OF KANGAROOS.

By A. S. Le Souef, C.M.Z.S.

(Four Text-figures.)

[Read 25th July, 1928.]

Macropus melanops Gould.

Proc. Zool. Soc., 1842, p. 10.

Although the external differences between *M. melanops* and *M. giganteus* have been emphasized (*Aust. Zool.*, iii (4), 1923, 145), the special skull and teeth characters of the former species have not received attention. Examination of a series of crania in the Australian Museum shows that *M. melanops* has skull and dental features that differentiate it from other kangaroos and justify it receiving specific rank.

Skull.—The anterior palate is narrow, its least breadth going 4-4½ times into the length of the diastema, as against 3-3½ times in *giganteus*, while the posterior palate is usually more perforated than in the latter species. The basi-zygomatic is broad, twisted at right angles, and generally recurved, with the anterior angle acute (Text-fig. A). The same bone in *giganteus* is stouter, narrower, with the anterior face blunted and, except in aged animals, not recurved (Text-fig. C).

Teeth.—*M. melanops* has I^3 comparatively small, its breadth being only two-thirds that of I^2 and I^1 combined, while the anterior notch is not always clearly indicated (Text-fig. B). P^4 is very small, its length being only one-half to two-thirds that of P^3. These teeth are thus very different in size from those of *M. giganteus* (Text-fig. D).

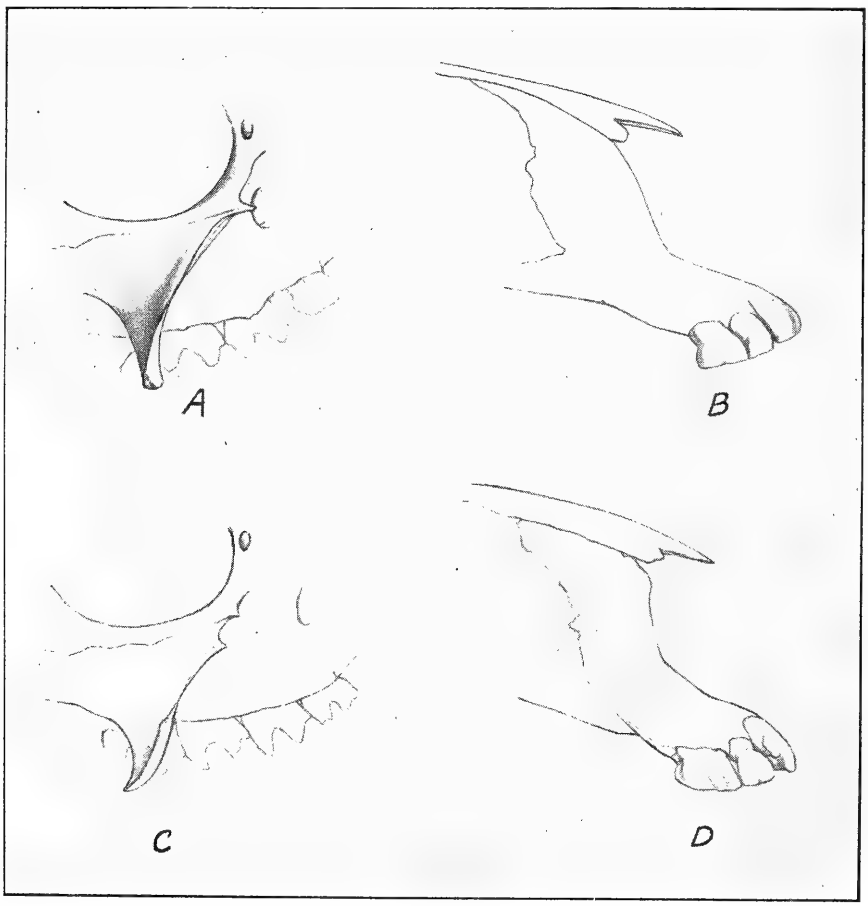
Macropus hagenbecki Rothschild.

Nov. Zool., xii, 1905, 509; xiv, 1907, 333; xvii, 1910, 108.

The first description of this species, without skull or teeth characters, led one to believe that it was allied to *M. rufus*. Examination of the type in the Tring Museum, however, shows that it is closer to the *robustus* group, with which it agrees in build of the body, shape of the rhinarium, arrangement of hair on the face, and complete posterior palate. It agrees with *M. rufus* in character of the coat, which is dense and woolly, facial markings, contour of the face, a broad occipital process, and the absence of small connecting bridges to the anterior bar of the molars. The sexes are alike in colouration. In appearance it is like a red wallaroo with a woolly coat, and having the characteristic facial markings of the Red Kangaroo. It is apparently intermediate between the two, and, I judge, quite a good species. The locality from which the specimens came is unknown. Its woolly coat, however, indicated a cold climate, and one would expect to find it on the higher ranges of Arnhem Land.

MACROPUS BERNARDUS Thomas.

This species apparently occupies a restricted territory on the South Alligator River. It is a small animal, allied to the *robustus* group, with which it agrees in build, character of the hair, colouration of the sexes (*Aust. Zool.*, ii (4), 1922, 142), complete posterior palate, and some teeth characters. It differs, however, in certain



Text-figs. A-D.

A. Basi-zygomatic of *Macropus melanops*.
B. Incisors of *M. melanops*.
C. Basi-zygomatic of *M. giganteus*.
D. Incisors of *M. giganteus*.

skull formations mentioned by Thomas (*Nov. Zool.*, 1904, 225), and also has dental features which do not appear to have been mentioned hitherto. These, together with additional skull characters, are here recorded.

Skull.—Compared with *robustus* the adult cranium is much smaller, more lightly built and flatter in profile. The nostrils are a little bowed at the sides,

nasals expanded posteriorly, and produced anteriorly in a comparatively long blunt point; postorbital process distinctly indicated; infra-zygomatic process very short and blunt; incisive foramina long, reaching the incisive suture. The least width of the posterior palate goes into the length of the diastema about twice.

Teeth.—Molars with a narrow anterior ledge and a small connecting bridge. The third and second incisors appear to be diagnostic of this species, the notch in both being strongly marked; the exposed portion of I^3 is completely cleft, the tooth appearing as if double, with the anterior fold partly overlying the posterior section.

MACROPUS GIGANTEUS TASMANIENSIS Le Souef.

Aust. Zool., iii (4), 1923, 146.

Very few authenticated specimens of the Tasmanian Forester Kangaroo seem to have been preserved in museums, and the animal has not received much attention. Gould obtained one large male, with a damaged skull, which is now in the British Museum (Natural History). Mr. Reid, curator of the Zoological Gardens, Hobart, kindly forwarded the skulls and skins of two females which have been placed in the Australian Museum, Sydney. Examination of these three

Table of Skull Measurements (in millimetres).

	M. melanops.			*M. hagenbecki.*	*M. bernardus.*	*M. g. tasmaniensis.*
	♀	♀				♀
Basal length	160	163	173	137	125	147
Greatest breadth	82	81	89	87		90
Nasals—						
Length	67	76	73	67	48	64
Greatest breadth	26	25	26	25·5	21	19·5
Central breadth	18	18	18	17	15	14
Palate—						
Length	112	114	—	96	83	99
Breadth outside M^2	49·5	51	51	42·5	39	47
Breadth inside M^2	30	30	28	27·5	21	28
Palatal foramen	—	—	14	14	9	9
Diastema	56	56	58	41	25	49
Basi cranial axis	45	45	50	38	35	41
Basi facial axis	115	118	123	106	90	118
Facial index	262	262	246	278	257	287

specimens, together with several live ones in the City Park, Launceston, and the Hobart Zoological Garden, has enabled more definite information to be gathered concerning the subspecies. It is closely allied to *M. giganteus giganteus* of the mainland, apparently differing only in having the teeth comparatively larger, and the basi-zygomatic broader and recurved. External appearance is the same in the typical species and the Tasmanian subspecies. A previous description, indicating variations in colour, received from the Tasmanian Museum, was apparently based on *M. ruficollis bennettii* (*Aust. Zool.*, iii (4), 1923, 145).

Hair fine and dense (Autumn pelage). General colour above dark grey with a brownish wash, blackish on the dorsal area and lighter on the flanks; hairs on

the under surface are white tipped, especially on the inguinal region and chest; head coloured like the back, back of the ears coarsely haired; thighs brownish-grey; paws and toes black; tail darkening to blackish towards the tip.

The skull agrees with the typical mainland type, with exception that the basi-zygomatic is broad and recurved. The lower jaw is stouter, and all teeth comparatively larger, being 0·5 to 1 mm. greater in measurement than those of a *giganteus* of similar size.

Very few Tasmanian Forester Kangaroos appear to be left. Although totally protected, they are nevertheless caught in snares set for Bennett's Wallaby, and are apparently being rapidly destroyed.

NOTES ON AUSTRALIAN LYCAENIDAE. Part vi.

By G. A. Waterhouse, D.Sc., B.E., F.E.S.

(Plate xxv.)

[Read 29th August, 1928.]

Part v of these notes was published in These Proceedings for 1912, pp. 698-702, and in 1914 "The Butterflies of Australia", by Waterhouse and Lyell, in which the Australian Lycaenidae were thoroughly revised, was issued. Since 1914, only one new species has been described but several new subspecies have been found, and many important extensions of the ranges of known species require record. The localities given in this paper are additions to or amendments of those in "The Butterflies of Australia".

Candalides Hübner.

Verzeichniss bekannter Schmettlinge, 1816, 73.

The type of this genus is *xanthospilos* Hübner, and good figures of the upper and under sides of both sexes were given in the first volume of his "Sammlung Exotischer Schmetterlinge", pl. 99, but no locality was given. The dates of publication of Hübner's work have been fixed as 1806-1819 for the first volume, so, considering the early date, it is best to consider Sydney, where the species is very common, as the type locality.

Polyommatus hübneri Godart (*Encyclopédie Méthodique*, 1824, 677), of which the male is described from Timor, is the same species, but the locality given is incorrect. *Erina pulchella* Swainson (*Zoological Illustrations*, ii, 1834, pl. 134) is the same species. Swainson gives here an enlarged coloured illustration of the upper side and under side of a male; the locality given is Australia. Miskin (*Ann. Q'land Mus.*, i, 1891, 64) gives *Lycaena byzos* Boisduval as another synonym, but I will show later in this paper that this is not correct.

At the end of 1914, Mr. H. W. Simmonds found larvae of *xanthospilos* at Stanwell Park feeding on *Pimelea ligustrina*. I have had numerous larvae at different times feeding on this plant and also on *Pimelea linifolia* and they have a distinct resemblance to the larvae of *C. heathi*, *C. hyacinthina* and *C. absimilis*; the pupae also resemble the pupae of those three species in that they are much flattened, with the abdomen produced to lateral ridges and so strikingly different from the usual pupae of the Lycaeninae. In December the pupal duration is 11-14 days. Now that the larva and pupa of *C. xanthospilos* are known, and are so different from those of *Philiris ilias innotatus* Miskin, I have no hesitation in claiming that *Philiris* is a genus distinct from *Candalides* as I pointed out in These Proceedings, 1912, p. 699.

Candalides heathi Cox.

Lycaena heathi Cox, *Entomologist*, 1873, 402.—*Lycaena paradoxa* Guest, *Trans. Roy. Soc. S. Aust.*, 1882, 36.

The types of *heathi* came from Mt. Barker, near Adelaide, and of *paradoxa* from Balhannah, 15 miles ESE of Adelaide and the two descriptions undoubtedly refer to the same insect. The species has a wide range, being found in all the Australian States except Tasmania. One subspecies has been described from the Monte Bello Islands and I now add another from Mt. Kosciusko.

CANDALIDES HEATHI HEATHI Cox.

Waterhouse and Lyell, *Butterflies of Australia*, 1914, p. 78, figs. 382, 383.

Male. Upper side: Forewing bronze brown; termen very narrowly brown-black; cilia brown-black, with tips whitish. Hindwing bronze-brown; costa and termen narrowly brown-black, with tips whitish.

Under side: Forewing silky grey-white; termen with a series of small, sometimes minute, dots, black. Hindwing silky grey-white; termen with a series of dots, black.

Female. Upper side: Forewing dull brown; an obscure central area reaching base and dorsum, dull bluish-purple; termen very narrowly brown-black; cilia brown-black, at tips whitish. Hindwing dull brown, tinged bluish-purple; costa and termen obscurely brown-black; cilia brown-black, at tips whitish.

Under side as in male.

I have only four males and one female from near Adelaide and these show the under side tinged with blue as mentioned by Cox. Specimens from Sydney only have blue towards the base of the wings, if at all. Probably if long series were obtained from Adelaide and in good condition it would be possible to separate Sydney specimens from them. My specimens from S. W. Australia are all smaller and, though not in the best condition, seem to indicate another race, but I await more material. These have a much darker under side than typical specimens. At present I would limit the typical form to S. Queensland and south along the east coast, the southern coast and the western coast to Geraldton and, as additional localities to those in "The Butterflies of Australia", I have *heathi* from Clermont, Q. (Sept.), Belmont, Q. (Oct.), Eidsvold, Q. (Jan.), near Adelaide (Nov., Dec., Jan.), Busselton, W.A. (Jan.), Perth, Kojarina, W.A. (Sept.), Moonyoonootha, W.A. (Sept.). I have only found the larvae of this race feeding upon two different species of introduced *Plantago*, but Mathew records its food plant as *Westringia rosmariniformis*, around which I have often seen the insect flying. The pupal duration during December and January is 16 to 19 days.

CANDALIDES HEATHI AERATA Montague.

Proc. Zool. Soc. London, 1914, 644.

This form is confined to the Monte Bello Islands and is much smaller than the typical race; it is generally darker above and on the under side of both wings; the terminal spots are more distinct than in the typical race. I have two males and one female from the type locality, caught in June.

CANDALIDES HEATHI ALPINA, n. subsp.

Male. Upper side slightly paler than the typical race, with the terminations of the veins very much paler brown, giving the wings a rayed appearance.

Under side grey-brown with two terminal black dots in the forewing and six in the hindwing.

Female. Upper side slightly paler than the typical race with the bluish-purple restricted to a small basal portion.

Under side grey-brown with six terminal black dots in both wings, those of the hindwing being distinctly larger.

The very distinctive under side at once separates this race, as it is so different from the silky white of the typical race. I have one male, which has a distinct pale brown border within the terminal brown-black lines to the wings above. The terminal spots on the under side of the forewing vary very much in size, and in number from two to six, though I have only one male with six and in one female they are so small as to be indistinguishable without a lens.

Holotype male, Mt. Kosciusko, 5,000 feet, 10th Dec., 1921, and during the previous five days the allotype female and six perfect paratype males and two perfect paratype females were caught, together with several worn specimens. I found the species always flying where a species of *Plantago* was growing. I also have three specimens caught in November and one in January at Mt. Kosciusko.

Candalides cyprotus Olliff.

Chrysophanus cyprotus Olliff, Proc. Linn. Soc. N. S. Wales, 1885, 716.—*Holochila purpurea* Grose Smith and Kirby, *Rhop. Exot.*, pt. 39, 1897, p. 7, Pl. x, figs. 11 and 12.

Olliff described both male and female from Katoomba, N.S.W., caught in September and the two specimens named as such in the Australian Museum are undoubtedly his types. In the "Rhopalocera Exotica" the male only is described and figured from Sydney and Moreton Bay. I have frequently caught specimens of the species in Sydney and they agree with those I have taken at Katoomba and also with my Brisbane specimens. In Sydney the species is only taken in the spring, but in Brisbane it is found again in the autumn.

The pupal duration of this species is remarkable. In March, 1924, Mr. L. Franzen found a batch of pupae on One Tree Hill, Brisbane. He sent me two of these which produced males on 30th August, 1924, and 4th November, 1924. His own pupae produced males and females during September and October, 1924. On 8th December, 1924, he opened a pupa and found it still alive and another he opened on 8th February, 1925, was still alive and some emerged during the following months. In July, 1925, he gave me his two remaining pupae, one of which produced a male on 29th September, 1925, so it had remained as a pupa for at least 18 months.

Candalides erinus Fabricius.

I have taken this species in worn condition in April at Port Macquarie, which extends its southern limit considerably.

Adaluma urumelia Tindale.

Trans. Roy. Soc. S. Aust., 1922, 537, Pl. xxxi.

This species is known from two males from the Roper River (March), in the South Australian Museum and a male in the National Museum, Melbourne, from King River, N. Aust. (4th Jan., 1915).

Pseudodipsas digglesi Hewitson.

The type undoubtedly came from Brisbane, as Diggles lived there and Hewitson received the species from him. My Brisbane dates are June to September and I also have it from Yeppoon in July and near Cairns in February.

MILETUS DELICIA DELICIA Hewitson.

Hewitson described this species from a specimen in the Grose Smith Collection from Australia. He does not mention the sex, but his description seems to indicate a female, especially as he gives the size as $2^{1}/_{20}$ inch, which is very large, much larger than my largest female which is from New South Wales. The races *delos* from Victoria and *duaringae* from near Rockhampton are both smaller than the race *delicia*. Druce (*Trans. Ent. Soc. London*, 1891, 186, Pl. x, figs. 6, 7) says that only three specimens were known to him, the type, a male in the Hewitson Collection from New South Wales and a female in the British Museum from Moreton Bay. Druce figures a male which agrees with the Brisbane race and I suggest that Brisbane be considered the type locality. In July, 1919, I found several larvae on Stradbroke Island feeding on *Acacia Cunninghami* which produced butterflies from the end of September to the middle of December, with a pupal duration of about one month. Mr. E. J. Dumigan also sent me a male from Killarney, Q., taken in January.

MILETUS DELICIA DUARINGAE Waterhouse.

PROC. LINN. SOC. N. S. WALES, 1903, 167; *Butterflies of Australia*, 1914, 85, fig. 231.

When I described this in 1903 as a variety from Duaringa, Q., only a single male was known. In September and October, 1923, Mr. A. N. Burus secured a series at Westwood, which is no great distance from Duaringa. These specimens show that *duaringae* must be considered the northern race of *delicia* and not an aberration. The males have the metallic areas on the upper side much bluer and much more extended than in those from Brisbane, and on the under side the ground colour is much paler than in Brisbane specimens and the coloured markings of the forewing are yellower than those of the hindwing. The under side of the forewing has often three black spots whereas the type has only two. In the females the metallic areas are not much more extended than in *delicia* but they are a much paler metallic blue, the irregular tornal orange-red spot extends as a terminal band towards the apex, in one specimen almost reaching it, and in that same specimen a similar but narrower and paler band is found on the forewing. The under side is as in the male, but ground colour somewhat darker.

The holotype male from Duaringa is in Mr. G. Lyell's Collection and I have males and females from Westwood in January, September and October, and Mr. Burns has other specimens from the same locality.

MILETUS HALYAETUS Hewitson.

Hewitson's locality for this species is Swan River, W.A. Until recently I only knew this species from Geraldton, but Mr. J. Clark gave me a pair he had caught at Perth. I visited the spot with him in August, but we saw none, nor was the species on the wing at Geraldton during the same month, and I think that October would be the best month for the species. I cannot see any striking differences between my Perth pair and my Geraldton series, but should a longer series from Perth show sub-specific differences, *Polyommatus uranites* Meyrick, described from Geraldton specimens, will be available for the northern race. I also have specimens from the Peron Peninsula in September and October.

MILETUS EPICURUS Miskin.

The types of this species are in the Queensland Museum, from Brisbane, and Mr. L. Franzen has recently taken it at Burleigh Heads. I caught a male at Coff's Harbour in September, which is a new record for New South Wales.

MILETUS APOLLO Miskin.

Ann. Q'land Museum, i, Supplement, 1891.

Miskin described this handsome species from a male (he thought it might be a female) found between the leaves of a book, where it had been preserved with other butterflies. The locality was on the Herbert River and probably near Ingham and the holotype is now in the Queensland Museum, where I have examined it. Owing to the treatment it had received, it is in very poor condition, but is easily recognizable.

This specimen remained the only one known until 1907, when I received several from Cape York from the late H. Elgner. Later on Mr. F. P. Dodd took the species in the Cairns district, where it has also been taken by Messrs. A. N. Burns and C. H. Borch. On receipt of specimens from Mr. Dodd and Mr. Burns I found that my Cape York specimens differed very considerably from them. Mr. Burns kindly compared his Cairns specimens with the holotype in the Queensland Museum and found that they agreed with it much better than the specimens from Cape York.

MILETUS APOLLO PHOEBUS, n. subsp. Plate xxv, figs. 6, 7.

Miletus apollo Waterhouse and Lyell, *Vict. Nat.*, xxvi, 1909, 111; *Butterflies of Australia*, 1914, 86, figs. 880, 881.—*Hypochrysops apollo*, Grünberg in Seitz Macrolepidoptera, p. 844, Pl. 145*b*.

As this race has already been very lengthily described and figured it is not necessary to repeat the descriptions. The males are all much deeper in colour on the upper side than in the typical race and the black costal band of forewing does not extend so far basad and shows a slight downward extension at the end of cell. The underside is well illustrated in the coloured figures that are given and is very much darker and richer than in the typical race, especially the apex of the forewing and the lower half of the hindwing. The same remarks apply to the upper side in the females as in the males, with the addition that the broad black costal band of the hindwing never reaches the apex, but is usually separated from it by a broad band of colour, though in one of my specimens this is very narrow. My most heavily marked female has fewer dark markings than any of the females I have seen of the typical race. The underside is as in the male.

Loc.—Cape York (Jan., Mar., May, June, August to December), Prince of Wales Is. (June). I have figured the holotype male and allotype female from Cape York in my collection and I have also six paratype males and four paratype females from Cape York.

The late H. Elgner sent me a male that had emerged from a pupa he found at Cape York. He wrote that the pupa was found lying loose in a hole in a bulbous epiphyte, which had a substance something like a potato, and from the bulb grew a stalk with leaves. The hole in which the pupa was found had been eaten, as were also the leaves, but he was uncertain if the larva fed on bulb or leaves or both. He sent me the empty pupal case, which is ovoid in section and rather elongate and it shows only very faint brown spots.

MILETUS APOLLO APOLLO Miskin. Plate xxv, figs. 8, 9, 10.

Male. Upper side: Forewing orange; apex and termen very broadly black; cilia orange. Hindwing orange; termen with a narrow black line and with long black scales at the terminations of the veins, especially towards the tornus; cilia orange. Under side as in the race *phoebus*, but the elongated spots below the apex of the forewing and the markings of the lower half of the hindwing almost

white and an additional large white patch at the end of the cell of the forewing; cilia pale orange, at terminations of veins black.

Female. Upper side: Forewing orange, paler than in male, apex and termen very broadly black; cilia pale orange. Hindwing orange, with a very broad black costal band always reaching the termen at apex; termen with a narrow black line, widest at terminations of the veins; a variable subterminal black band varying from the irregular band of Plate xxv, fig. 9 to the broad band of fig. 10; cilia pale orange.

Under side as in the male, but markings whiter and the white patch at end of cell of forewing smaller; in the forewing the reddish-brown band extends irregularly to the tornus; cilia pale orange, at terminations of veins black.

I have in my collection three males and three females from Mr. Dodd and Mr. Burns, and I have before me, besides these six specimens, six males and four females belonging to Mr. A. N. Burns.

Whilst the males of *phoebus* are very constant on the upper side, these males vary somewhat in colour, being an orange-vermilion to an orange-red, but never the very rich colour of the Cape York race. In some specimens there is a dark patch of scales on the termen near the apex of the hindwing and indications of a black subterminal band of black spots, more noticeable near the tornus. In the females the greatest variation is shown on the upper side of the hindwing; this difference is shown in the figures which are from specimens given me by Mr. Dodd. The specimens belonging to Mr. Burns show a gradation between these figures.

Besides the different shade of colour of the upper sides and the very distinct under sides, this race may be distinguished from *phoebus* by having a black terminal line in both sexes, and in the female the black costal border reaching the termen on the hindwing above.

The localities for this race are Herbert River (Miskin), Cairns District (F. P. Dodd), Meringa, near Cairns (January, February and October; A. N. Burns).

Mr. A. N. Burns, who has bred this fine species, supplies me with the following notes: Larvae when fully grown about an inch long, of the usual Lycaenid shape. In colour they are translucent grey with obscure pale brownish spots which almost coalesce in the lateral areas. Dorsal line interrupted, brownish-green. Whole dorsal surface roughened, lateral margins crenulate. Ventral surface pale greenish. Both extremities depressed. Larvae live in a cellular bulbous epiphyte, on which they feed, as well as on the leaves growing from the bulbs. These bulbs, even if they do not contain larvae or pupae, are the home of a species of small brown ant (*Pheidole*) which, however, does not attend the larvae in the same way as ants attend the larvae of *Ogyris*. Pupa about five-eighths of an inch long, found attached within the eaten-out portions of the bulbs. In colour they are pale yellowish-brown, with the whole surface covered with minute dark brown spots.

Mr. Burns informs me that the epiphyte belongs to the Rubiaceae and Mr. E. Cheel identifies it as *Myrmecodia tuberosa*. It grows on *Tristania*, *Melaleuca* and other forest trees.

The pupal shells given me by Mr. Burns show the brown markings much more plainly than the one I have of the race *phoebus* from Cape York.

Mr. C. H. Borch (*Vict. Nat.*, xliii, 1926, 214) has given a short account of the life history of this butterfly. He says that the bulbs of the epiphyte were honeycombed with tunnels made by small black ants and when opened had the appearance of a sponge. Some of the older bulbs examined were little more than shells, having been eaten out by generations of larvae. A larva pupated on 25th January

and a male emerged on 12th February. He remarks: "It is remarkable that in travelling through the tunnels of the bulb, these butterflies do not injure their delicate wings. Apparently immediately on emergence from the pupa, they crawl towards the light, development of the wings being checked until the insects are out in the open".

When I was returning from Perth in September, 1926, I had a number of pupae of *Xenica* and *Ogyris* in a small cardboard box. I found that the *Xenica* always emerged satisfactorily, but the *Ogyris* never properly expanded and were evidently trying to reach the light. After this experience for two days, I examined the box every quarter of an hour in the train and as soon as an *Ogyris* had emerged, it was at once transferred to a large glass-bottomed pill box and so all subsequent emergences produced perfect insects. I had a similar experience with a female *Pseudodipsas brisbanensis*. The butterfly was placed in a large pill box in hopes that it would lay eggs. The box, which unfortunately had a hole in the lid, was placed glass side down on a window sill; when examined some hours afterwards, the wings of the butterfly were all broken in its endeavours to escape through the hole, which was only just large enough to allow the body of the insect to get through.

MILETUS APOLLO WENDISI Bethune-Baker.

Hypochrysops wendisi B.-Baker, *Ann. Mag. Nat. Hist.* (8) iv, 1909, 184, Pl. 7, fig. 5.

This is certainly another race of *M. apollo*, the holotype being a female in the collection of Sir George Kenrick from Wendisi, Geelvink Bay, New Guinea. No doubt other races will be found in the coastal parts of New Guinea, but the species is certainly a rare one and its habits are such that it is not easy to secure.

MILETUS BYZOS Boisduval.

Lycaena? byzos Bois., *Voy. Astrolabe*, Lep., p. 81, 1832.

This name has passed unnoticed and almost forgotten since it was first proposed, except that Miskin considered the species the same as *xanthospilos* Hübner. This is unlikely as, under the name of *hübneri*, *xanthospilos* was described by Boisduval immediately preceding his description of *byzos* in the same work.

Boisduval describes *byzos* as follows:—

"Alis fuscis; anticis macula discoidea crocea; posticis fuscis fascia postica crocea; omnibus subtus subluteo-griseis obscuriori punctis".

"Ailes d'un brun noirâtre; les supérieures, avec une tache discoidale d'un jaune safran; les inférieures, avec une bande postérieure de la même couleur; dessous des quatre d'un gris lavé de jaunâtre, ponctué d'une couleur plus foncée.

"Il est un peu petit que *Hubneri*.

"Environs de port Jackson".

I have been informed by the authorities at the Paris Museum that the type of *byzos* could not be found there, but at the same time I was sent a photograph of the specimens Boisduval called *hübneri* and these were undoubtedly *xanthospilos*.

The first point I would make then, is that *byzos* cannot be *xanthospilos*, for Boisduval would not have described the same insect under two consecutive names, besides which, the description does not fit *xanthospilos*.

A free translation of Boisduval's Latin and French description is as follows:—

Wings blackish-brown; forewings with a discal saffron-yellow spot; hindwings with an outer band of the same colour; all the wings, on the under side, grey

tinged with yellowish, with deeper coloured spots. A little smaller than *hübneri* (= *xanthospilos*). From Port Jackson.

The only species to which this description could apply is the female of *Miletus hecalius* Miskin, described from Victoria. In a letter, the late Hamilton H. Druce, some years ago, expressed the opinion that I was probably correct in making this suggestion. Whilst *hecalius* was only known from Victoria, it would have been rash to insist that it was the same as *byzos*, but the species has been taken freely near Sydney, and within a mile of Neutral Bay, where the "Astrolabe" anchored from 2nd to 19th December, 1826, both larvae and butterflies have been taken, and only a few years ago the food-plant was growing close to the water's edge. Though, as a general rule, Sydney specimens of *hecalius* are not smaller than *xanthospilos*, I have caught some considerably smaller and these are without a central orange spot on the upper side of the hindwing, as is usually the case. Further, though bred specimens are rich yellow on the under side, captured specimens are much paler, and could easily be termed "grey tinged with yellowish". Though many specimens are heavily spotted on the under side, in others these red spots are small and obscured and in captured specimens do not strike the eye as they do in bred specimens.

As there are certain recognizable differences between the Sydney specimens and those from Victoria, two races are distinguishable.

MILETUS BYZOS BYZOS Boisduval.

Miletus hecalius Waterhouse and Lyell, *Butterflies of Australia*, 1914, 87, fig. 217.

Male. Upper side: Forewing rich purple; costa narrowly, apex and termen, broadly black; cilia dull black with tips greyish. Hindwing rich purple; costa with termen broadly black; a tornal streak usually reaching along the two branches of the cubitus, dull red, cilia grey.

Under side: Forewing yellow; dorsum grey; a bar across middle of cell, a bar at end of cell, and a discal band, red edged black and metallic green; termen orange-red with a central series of dots black, dusted metallic green. Hindwing dark grey-brown; bands typical, red narrowly-edged metallic green; termen broadly red, with an interrupted central line, metallic green.

Female: Upper side: Forewing brown-black; a central patch, reaching base by a narrow streak, orange; cilia brown with tips grey. Hindwing brown black; a variable spot at end of cell (sometimes absent), orange; a narrower terminal band, orange-red, this colour extending basad along the branches of the cubitus and median; cilia grey.

Under side: Forewing rich yellow; dorsum grey, markings as in male, but paler. Hindwing rich yellow; bands and spots as in male but usually brighter, rarely as large as in the male, often much smaller, especially on the hindwing on which some may be absent and others only faintly indicated.

Localities.—Sydney (Mosman and Como; Sept. to April), Mittagong (November), Tathra (November).

Males of this race are very constant and amongst a hundred specimens I have seen there are no marked differences. On the other hand the females are very variable, especially on the underside. I have good specimens that only show very faint markings on the underside of the hindwing.

The larvae of this race feed upon *Pomaderris lanigera*. The pupal duration varies from 13 to 38 days according to the time of the year the butterflies emerge.

Those that emerge from December to March take 13-15 days, October and November 23 to 29 days, and September up to 38 days.

MILETUS BYZOS HECALIUS Miskin.

Hypochrysops hecalius Miskin, *Trans. Ent. Soc. London*, 1884, 94, female; PROC. LINN. SOC. N. S. WALES, 1888, 1516, male; Anderson and Spry, *Vict. Butt.*, 1894, 96, figured.—*Miletus hecalius* Waterhouse and Lyell, *Butterflies of Australia*, 1914, 87, figs. 218, 226, 227 (not fig. 217).

The upper side in the males differs from the typical race in that the purple is slightly more extensive and lustrous; the tornal streak on the hindwing is brighter and larger and, besides extending somewhat along the veins, in two specimens reaches the apex as a narrow red terminal line. On the under side this sex is paler than in the typical race and the bands and spots decidedly smaller. On the upper side in the female the central spots are yellow rather than orange and the spot of hindwing is larger than in any of my specimens of the typical race. The terminal band of the hindwing is orange to orange-red and wider than in Sydney specimens. On the under side the colour is as described by Miskin, chrome-yellow, and the whole under side has a much duller appearance than the typical race.

Described from Victoria, the holotype female is now in the Queensland Museum and the allotype male in the South Australian Museum. It is known from Wandin, Narracan, and Gisborne (January) and Toora (December); four males and five females are in my collection.

THYSONOTIS HYMETUS TAYGETUS Felder.

Described by Felder from Australia and Fiji, the latter locality being erroneous. I consider typical *taygetus* to be the most southern Australian race and I have extended its range south considerably for I have taken it at Port Macquarie in April, at Toronto, Lake Macquarie in April, and one female at Narrabeen, near Sydney, in December. A pupa found at Southport, Q., in July emerged in 15 days, whilst larvae from Port Macquarie that pupated in Sydney at the end of April emerged in 20-28 days.

NACADUBA PALMYRA TASMANICA Miskin.

The holotype male is in the Queensland Museum and, as pointed out by Miskin (*Ann. Q'land Museum*, 1, 1891, 59), the locality "Tasmania" is incorrect, so it is advisable to accept Cairns, given by Miskin in 1891, as the type locality. I have taken a single male at Toronto, Lake Macquarie, in April, the southern-most record known.

NACADUBA ANCYRA FLORINDA Butler.

The type of this species in the British Museum is from the Loyalty Islands; if this locality is correct it is unlikely that our southern subspecies of *ancyra* is the same. At present I do not wish to make any alteration, but would record the race we call *florinda* at Stanwell Park in January (G. M. Goldfinch). The food plant, *Trema aspera* is growing there. I found larvae on this plant at Port Macquarie in April and they pupated by the end of the month and emerged in 41-48 days.

ZIZEERIA ALSULUS Herrich-Schaeffer.

In April I caught a specimen of this species on the road between Gloucester and Kranback; this is a new record for New South Wales.

ZIZULA GAIKA ATTENUATA Lucas.

Mr. G. H. Wyld has taken two or three specimens of this species in March at Beecroft, near Sydney, a record that extends its range south from the Manning River.

NEOLUCIA AGRICOLA AGRICOLA Westwood.

Several specimens have been taken at Mt. Kosciusko in December and January at 4,000-5,000 feet. As *N. hobartensis* was found there at the same time and place, there is no possibility of their being races of the same species.

NEOLUCIA HOBARTENSIS HOBARTENSIS Miskin.

The type is in the Queensland Museum, from Hobart. On a recent visit to Hobart, I found that this species did not occur below 3,000 feet, so the type locality is better defined as Mt. Wellington, near Hobart. At Mt. Kosciusko it occurs up to 7,000 feet. I also have it from Cradle Mountain and Underwood (2,800 feet), Tasmania, both in January.

NEOLUCIA HOBARTENSIS MONTICOLA Waterhouse and Lyell.

This race was abundant at Barrington Tops in January and February; by beating I secured several larvae feeding on the flower buds of an *Epacris*; their pupal duration was 11-12 days.

NEOLUCIA MATHEWI Miskin.

The type is in the Queensland Museum, from Sydney, where the species is strictly a coastal one and found in abundance near the food plant *Monotoca elliptica* in September and October. I have never seen the species north of Port Stephens, where it was very plentiful in October; it was also common at Narooma in the same month. Mr. Ian Harman has recently taken it at Underwood in Tasmania in January, which is quite a new record. My greatest surprise was taking it at Blackheath in November, 1922, where six specimens were seen and captured flying round a plant very similar to the coastal food plant. The pupal duration of Sydney specimens is 16-21 days.

PSEUDALMENUS CHLORINDA Blanchard.

The first mention of this butterfly is in the "List of the specimens of Lepidopterous Insects in the British Museum" (1847, part ii, p. 28), by E. Doubleday. Here Doubleday records, under the name *Ialmenus myrsilus*, eight specimens from Van Diemen's Land, one presented by Rev. A. Beaufort and four from the collection of Mr. Children, who had been a former Curator of Zoology at the British Museum. No description was given. As *Thecla chlorinda*, it was figured from Tasmania by Blanchard on the plates of the "Voyage Pôle Sud". We are told on page 2 of Volume 4 of the text of this voyage which was published in 1853, that the plates were published several years before the text, so the latest possible date for the plate must be 1851. The next mention is as *Thecla myrsilus* in the "Genera of Diurnal Lepidoptera", where it is figured from Van Diemen's Land, but again no description is given. The next species listed in the "Genera" is *Thecla chlorinda*, so the figures in the "Voy. Pôle Sud" must have been before that of the "Genera". Up to this time no description under either name had been given. The first description is that on page 401 of the "Voyage Pôle Sud", Vol. iv, 1853, where the sexes are described and *Thecla myrsilus* of the "Genera" sunk as a synonym. This history is sufficient to show that *myrsilus* must be sunk as a

direct synonym of *chlorinda* as I have already pointed out (These PROCEEDINGS, 1912, 701). In Seitz Macrolepidoptera, however, the name *myrsilus* is used. Three races have been described and I now add a fourth.

PSEUDALMENUS CHLORINDA CHLORINDA Blanchard. Plate xxv, figs. 1-4.

Thecla chlorinda Blanchard, *Voy. Pôle Sud*, Pl. 3, figs. 15-18 (ante 1853), description vol. iv, 1853, 401.—*Thecla myrsilus* Doubleday, *Gen. Diurn. Lep.*, 1852, Pl. 75, fig. 3; Waterhouse and Lyell, *Butterflies of Australia*, 1914, 113, figs. 863, 864.

Blanchard figured both sexes and his male is very close to the figure I give on Plate xxv, fig. 1, which is from Launceston. Figure 863 in the *Butterflies of Australia* is also from Launceston and is also close to Blanchard's figure of the male. I figure (Plate xxv, fig. 2) a female from Launceston without any central orange patch on the upper side of the hindwing; this figure is much duller above than Blanchard's figure of the female, which has an irregular central orange patch on the upper side of the hindwing. Figure 864 of the *Butterflies of Australia* is much nearer Blanchard's figure of the female. The most highly coloured specimens I have from Launceston are shown on Plate xxv, fig. 3 (male) and fig. 4 (female), the latter being very close to the figure given in the "Genera", which is that of a female. I have from Launceston a long series of this race (the South Australian Museum also has a fine series from the same place) and in both sexes they pass gradually from the extremes of both sexes I have figured on Plate xxv. My figures of the under sides show that the black markings are very variable in extent.

Though I consider that the types came from near Hobart, I have used Launceston specimens for illustration as I have no females from Hobart.

From Snug River, near Hobart, I have but eight males, all of which agree very closely with Plate xxv, fig. 3, and all have the under side marked as in that figure; they were taken in September and October, whilst my Launceston specimens were taken from October to December and are chiefly from a large batch of pupae found by the late F. M. Littler. This race feeds on species of *Acacia*.

PSEUDALMENUS CHLORINDA ZEPHYRUS Waterhouse and Lyell.

Ialmenus myrsilus, Anderson and Spry, *Victorian Butterflies*, 1894, 100, female figured.—*P. chlorinda zephyrus*, Waterhouse and Lyell, *Butterflies of Australia*, 1914, 114, figs. 436, 437, 438.—*Ialmenus myrsilus zephyrus* Seitz in Seitz Macrolepidoptera, Pl. 998, fig. 160*b*.

The holotype ♂ and allotype ♀ of this race from Gisborne, Vict., are in Mr. G. Lyell's collection, taken in September. I have also specimens taken at Gisborne where they feed on *Acacia melanoxylon*.

In this race the males and females are usually more highly coloured on the upper side than in Plate xxv, figs. 3 and 4, the female showing much more orange basad of the black cell bar of the forewing. On the under side in both sexes, the black markings are usually as in Plate xxv, fig. 3 and only rarely approach those of fig. 1.

This race is confined to Victoria and has recently been taken at Moe in September, October and November.

PSEUDALMENUS CHLORINDA CHLORIS Waterhouse and Lyell.

Butterflies of Australia, 1914, 114, figs. 870, 871.

The holotype male, allotype female and paratype male from Katoomba (October) are in my collection. The coloured figures already given show this race very well, which is brighter on the upper side than *zephyrus* and a beautiful silky white on the under side. Mr. G. M. Goldfinch has recently taken a female of this race at Mittagong in November.

PSEUDALMENUS CHLORINDA BARRINGTONENSIS, n. subsp. Plate xxv, fig. 5.

Male. Upper side: Forewing as in *chloris*. Hindwing with the subterminal coloured band much enlarged and extended to join the central coloured patch.

Under side silky white, with the black and red bands as shown in the figure.

This fine race is known from a single specimen which was found dead on the snow near Edwards Hut, Barrington Tops, on 30th October, 1922, by the late John Hopson, Junr. I failed to find any trace of it there in January, 1925. This specimen shows a further increase of colour from the southern races. A Mr. Schraeder told me some years ago that he had taken specimens of a *Pseudalmenus* near Hanging Rock, but had disposed of them. They would probably be this race. The holotype male which is at present unique is in my collection.

EXPLANATION OF PLATE XXV.

1. *Pseudalmenus chlorinda chlorinda*, ♂, Launceston, Tas.
2. *Pseudalmenus chlorinda chlorinda*, ♀, Launceston, Tas.
3. *Pseudalmenus chlorinda chlorinda*, ♂, Launceston, Tas., 9th Nov., 1917.
4. *Pseudalmenus chlorinda chlorinda*, ♀, Launceston, Tas., 2nd Nov., 1917.
5. *Pseudalmenus chlorinda barringtonensis*, holotype ♂, Barrington Tops, N.S.W., 30th Oct., 1922.
6. *Miletus apollo phoebus*, holotype ♂, Cape York, Q., 2nd Oct., 1910.
7. *Miletus apollo phoebus*, allotype ♀, Cape York, Q., 18th Sept., 1910.
8. *Miletus apollo apollo*, ♂, Meringa, Cairns, Q., 16th Febr., 1926.
9. *Miletus apollo apollo*, ♀, Cairns District, Q.
10. *Miletus apollo apollo*, ♀, Cairns District, Q.

Figures from specimens in Waterhouse Collection.

A REVISION OF THE AUSTRALIAN BOMBYLIIDAE (DIPTERA). Part ii.

By Frederick H. S. Roberts, M.Sc.

[Read 29th August, 1928.]

Subfamily Bombyliinae.

Head usually smaller than in the Exoprosopinae, rarely transverse or wider than the thorax; occiput little convex, never bilobate or with a central cavity; eyes contiguous or subcontiguous in the male, distinctly separated in the female, their hind borders entire. Antennae approximate at the base, porrect, sometimes longer than the head, with an apical or subapical style of variable form, sometimes imperceptible. Proboscis variable in length, generally elongate and porrect; palpi always one-jointed.

Thorax generally arched, often much so, usually with dense furry pubescence and some bristly hairs.

Abdomen usually short, broad and rounded, rarely conical, with dense furry pubescence and long bristles or bristly hairs.

Legs generally long and slender, the femora with strong spines below, sometimes absent on the fore femora, and a circlet of apical spines to the tibiae; spines on tibiae arranged in three rows.

Wings stout, generally with well developed lobe and alula; R_{2+3} usually curved, sometimes almost straight, and arising from R_{4+5} well distant from r-m; cells R_5 and Cu sometimes closed.

This subfamily contains five genera in Australia, viz. *Bombylius*, *Systoechus*, *Dischistus*, *Sisyromyia*, and *Anastoechus*. *Sisyromyia* is confined to this region and *Anastoechus* is recorded from Australia for the first time. The descriptions of many of the species which come within the subfamily are very inferior and brief, and in many cases I have had to rely on White and Hardy, not only for the identification of these species, but for their generic position. White, fortunately, was able to examine many of Walker's types in the British Museum, and his identifications are no doubt correct.

Key to the Genera of the Bombyliinae.

1. Cell R_5 open, at most closed at the wing border 2
   Cell R_5 closed well before the wing border 3
2. Cell R much longer than cell M; i.e. the vein r-m is placed near or beyond the middle of cell mc ..... *Dischistus* Loew.
   Cells R and M of about equal length; i.e. the vein r-m is placed near the base of cell mc ..... *Sisyromyia* White.
3. Cells R and M of about equal length 4
   Cell R much longer than cell M ..... *Bombylius* Linnaeus.
4. Face prominent and moderately pilose; head not as broad as thorax ..... *Systoechus* Loew.
   Face rounded and very densely pilose; head as broad as thorax ..... *Anastoechus* Osten Sacken.

Genus Systoechus Loew.

Systoechus, Loew, *Neue Beitr.*, iii, 1855, 34; White, *Proc. Roy. Soc. Tas.*, 1916, 196; Hardy, *Proc. Roy. Soc. Tas.*, 1921, 69; 1923, 83.

Genotype, *Bombylius sulphureus* Mikan, by designation of Coquillett, 1910.

Head small, semicircular, set rather low and closely applied to thorax; occiput moderately convex; eyes in male, usually contiguous for various distances, in female, wide apart; frontal triangle of moderate size, or rather large; face prominent between the eyes, clothed with dense appressed pile and erect hairs; proboscis very long, usually slender, with rather small labella; palpi usually short and thin. Antennae usually as long as the head, sometimes longer, the first segment long and cylindrical, the second short, about half as long as the first, the third longer than the first two together, sometimes much longer, variable in shape, constricted at base, with a small jointed style, sometimes a little subapical.

Thorax broad, somewhat oval, arched, with dense furry pubescence, the postalar bristles usually not conspicuous; scutellum large, semicircular, clothed like the thorax, the bristles long and slender; squamae not very large, with a rather sparse hairy fringe; halteres slender.

Abdomen short, usually broad and rounded or somewhat obconical, clothed with dense furry pubescence, and with long bristles or bristly hairs on the hind borders of the segments.

Legs long and thin, with distinct spines; hind legs elongate, hind and middle femora with long spines below, more numerous on the former; pulvilli distinct; empodium minute.

Wings at rest, outspread, rather narrow, with well developed alulae; cell Sc, except towards apex, almost obliterated by the contiguity of the veins Sc and R_1; R_{2+3} usually curved at apex, never recurrent, rarely straight; r-m placed well before the middle of cell mc, so that cells R and M are of approximately equal length; cell R_5 closed well before the margin; cell Cu open; apical cross-vein of cell mc never or very rarely longer than r-m.

Range.—World-wide.

Key to the Species of Systoechus.

1. Apex of abdomen with dark tufts; abdomen with a dark band 2
   Apex of abdomen without such tufts; abdomen without a dark band 5
2. Wings usually with clear spots; fore tibiae of male with small spines of almost equal size ..... *platyurus* Walker
   Wings never spotted; fore tibiae of male with some very large spines on its apical half 3
3. Middle tibiae with two rows of very large and strongly developed spines; pubescence red tinted ..... *callynthrophorus* Schiner
   Middle tibiae devoid of such spines; pubescence rarely red tinted 4
4. Fore tibiae with one or two much developed apical spines; apical tuft of abdomen divided at apex only; femora partly brownish ..... *albiceps* Macquart
   Fore tibiae without such apical spines; apical tuft of abdomen wholly divided; femora black ..... *sericans* Macquart
5. Large species with tawny pubescence 6
   Small species with yellowish or white pubescence 7
6. Head not nearly as broad as thorax; pubescence tawny; wings smoky ..... *australis* Guérin
   Head about as broad as thorax; pubescence bright tawny; wings almost hyaline, at most yellowish at base and along the fore margin ..... *distinctus* Walker
7. Pubescence almost wholly white ..... *albohirtus*, n. sp.
   Pubescence yellowish 8
8. Face with white hairs 9
   Face without white hairs 10

9. Third antennal segment very broad; abdomen somewhat reddish .... *rubidus*, n. sp.
Third antennal segment not in the least broad; abdomen with rather large yellowish lateral areas ..... *cinctiventris*, n. sp.
10. Pubescence bright yellow; wings fairly clear ..... *flavovillosus*, n. sp.
Pubescence pale yellow; wings smoky ..... *pallidus*, n. sp.

The females of *albiceps*, *sericans* and *callynthrophorus* are not included in the above key. That of *callynthrophorus* may be recognized by the reddish colour of the pubescence in conjunction with the brownish femora; that of *albiceps* by the partly brownish femora and the undivided abdominal tuft and that of *sericans* by the black femora and wholly divided tuft, the two latter species but rarely having any reddish tint to the pubescence.

Eleven species have been recognized as belonging to the genus, five being described as new. Nothing is known of the life histories of any of the species, though the habits of the adults point to their being parasitic on Hymenoptera and Orthoptera. In Europe and America this genus has been recorded as parasitic on the egg-masses of grasshoppers and the manner in which some of our smaller species alight on the ground makes it possible that the hosts of the larvae are somewhat similar in Australia. Most of the species occur from early spring to about midsummer, the larger banded species, *platyurus*, *sericans*, *albiceps* and *callynthrophorus*, being rather numerous during the flowering of Leptospermums. From the manner in which these larger species fly, and the buzzing sound produced by the rapid vibrations of their wings whilst hovering, the popular name of "bee flies" has no doubt been derived.

Distribution.—The genus, so far as known, is principally distributed along the eastern portion of the Continent, and appears richest in species in Queensland. Of the eleven species known, *cinctiventris* and *flavovillosus* occur in Queensland only; *albiceps* occurs from Queensland, through New South Wales to Victoria, and appears mainly coastal in habitat; *sericans* from Western Australia, probably across the central areas, to Southern Queensland; *australis* from New South Wales to South-eastern Queensland; *rubidus* and *pallidus* from New South Wales to South-western Queensland. Of the remaining species, *platyurus* is recorded from all States, but is confined to the southern half of the Continent; *distinctus* and *callynthrophorus* from New South Wales and *albohirtus* from South Australia.

Systoechus platyurus (Walker).

Bombylius platyurus, Walker, *List Dipt. Brit. Mus.*, ii, 1849, 286.—*Systoechus platyurus*, Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 69; 1923, 83.—*Bombylius crassus*, Walker, *List Dipt. Brit. Mus.*, ii, 1849, 287; Hardy, *Proc. Roy. Soc. Tasm.*, 1923, 83.—*Systoechus crassus*, White, *Proc. Roy. Soc. Tasm.*, 1916, 196.—*Bombylius notatipennis*, Macquart, *Dipt. Exot.*, suppl. 5, 1854, 78.—*Bombylius punctipennis*, Thomson, *Eug. Resa*, Dipt., 1868, 487.

♂. Head mainly greyish, frons and upper portion of face somewhat darker; occiput moderately convex, clothed with short, dense, and equal pale golden or pale reddish hairs, which become much paler below to form a soft, whitish, sparse, beard; eyes contiguous from just below the ocellar tubercle for about one-third the length of the frons, their upper and inner facets slightly enlarged; ocellar tubercle black, rather small, with long, erect, pale golden and reddish hairs; frontal triangle large, clothed with dense, appressed, pale golden pile, the median groove distinct; face with dense pale golden and soft hairs, the basal portion of the cheeks bare; mouth opening long and broad, its borders yellowish with a short golden

moustache, and bearing on the upper border a tuft of about six short, bristly, reddish hairs. Antennae longer than the head, the first segment with dense pale golden, and sometimes with some intermixed black hairs, the second short, not more than half the length of the first, the third longer than twice the length of the first and second together, somewhat elongate conical in shape, its apical fourth very slender and almost linear, and provided with a small but distinct apical style. Proboscis usually very elongate and slender, very variable in length, usually about three times the length of the oral opening; palpi small, slender, blackish.

Thorax grey-black, with three black, narrow, longitudinal stripes, the whole densely clothed with short pale reddish or golden hairs which, viewed from above, appear rather paler on the sides, and from the front the whole has a very pale golden yellow sheen; the posterior portion contains many more definitely reddish hairs, which are more concentrated near the scutellum; postalar calli with tufts of black hairs below; scutellum grey-black, clothed with dense greyish pile, and provided with long, reddish bristles; pleurae and breast clothed with dense hairs, rather paler than those on the dorsum; squamae very pale with a dense pale fringe; halteres brownish with reddish knobs.

Abdomen blackish, broad and rounded, clothed with dense, intermixed reddish and grey pubescence, the latter being rather appressed; posterior border of second segment with a band of dense black and intermixed reddish hairs, which extends laterally and is somewhat whitish immediately below; on the apical segments is a very dense tuft of longer black and some intermixed reddish hairs, which appears to be divided into two distinct apical tufts, the dorsum thus appearing to be clothed with dense reddish hairs with a black band and two apical black tufts; bristles reddish; venter with dense, pale reddish and intermixed white hairs.

Legs mainly reddish, the basal half of the fore femora, and the bases of the middle and posterior femora, and apical tarsi, black; coxae black, and with femora below, with long pale hairs, the legs otherwise with reddish or somewhat golden scales, the femora with appearances of white scales at their bases; spines reddish; hind femora with a row of about twelve long spines below; middle femora with few similar spines below; apical spines of tibiae rather short; pulvilli pale.

Wings brown at the base and along the fore margin for about two-thirds the length and one-third the breadth, the remainder of the wing greyish or pale smoky; greyish area with five fuscous spots placed on various cross-veins and bifurcations; apical cross-vein of cell mc rather large.

♀. Frons very broad at vertex, clothed with appressed pale golden pile, with erect black bristly hairs and some golden or reddish, short, bristles.

Length of body, 9-15 mm.; of wing, 8-14·5 mm.

Hab.—Queensland: Brisbane, Bribie Is.; Victoria: Cheltenham; South Australia: Mt. Pleasant, Kangaroo Is.; Western Australia: Albany, Perth, Geraldton, King George's Sound, Kelmscott, Smith's Hill; Tasmania: Hobart, George Town, Bridgeport.

I have no record of this species from New South Wales, though I feel certain the species occurs in that State, both *notatipennis* and *punctipennis* being described from Sydney.

This beautiful *Systoechus* is the first of the genus to appear on the wing around Brisbane. Its earliest record there is the end of July. It continues till about the end of September, and is particularly common on Leptospermums from the end of August to the middle of September. In Tasmania the dates range throughout December; in Victoria, October; in South Australia, November, and in Western

Australia, December (there is only one specimen of a series of nine from this State with the date of capture on the label).

In the series before me there are 17 ♂, 10 ♀ from Queensland, 3 ♂, 2 ♀ from Tasmania, 3 ♂ from South Australia, 2 ♂, 1 ♀ from Victoria, and 2 ♂, 7 ♀ from Western Australia. The description given above is taken from the Tasmanian form, described by White as *crassus*. The species from the eastern coast, and from Perth (W. Aust.) are practically identical with *crassus*, though the species around Brisbane is generally rather paler and smaller. On Bribie Island and at Dunwich, Moreton Bay, the pubescence becomes almost a bright red. One ♂ and two ♀ from Albany, Geraldton, and King George's Sound (W. Aust.) have the pubescence of the head white, that of the body greyish, with intermixed reddish hairs and bristles. The spots on the wings are very faint and in one specimen almost absent. This form is without doubt Walker's *platyurus*, which was described from Western Australia. The specimens from South Australia appear to be similar, the spots on the wings being hardly discernible. These specimens are badly damaged and very greasy, but, as far as I can judge, the pubescence is also mainly whitish. The form *platyurus* is apparently very closely related to *callynthrophorus* and its allied species, but the fore tibiae of the male never possess the sexual spines as found in *callynthrophorus*. In general, *platyurus* is a large species, which varies greatly in colour and in the distinctness of the infuscations of the wings, the former varying from greyish through pale golden to reddish, and the latter sometimes hardly visible. The species contains two distinct forms, the grey form, *platyurus*, which is confined to Western Australia and possibly South Australia, and the reddish form with distinctly spotted wings, mainly to Tasmania and the eastern coast.

Systoechus albiceps (Macquart).

Bombylius albiceps, Macquart, *Dipt. Exot.*, suppl. 3, 1848, 36.—*Systoechus albiceps*, Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 70.—*Bombylius vetustus*, Walker, *List Dipt. Brit. Mus.*, ii, 1849, 286.—*Systoechus vetustus*, Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 69.—*Bombylius penicillatus*, Macquart, *Dipt. Exot.*, suppl. 4, 1850, 118.

♂. Head mainly greyish; occiput moderately convex, densely clothed with long silvery white hairs, which completely cover a row of short, pale brown bristles; ocellar tubercle rather small, with some long, black, bristly hairs and some shorter, white hairs; eyes contiguous from below the ocellar tubercle for about one-third the length of the frons, the upper facets hardly larger; frontal triangle large and broad, clothed with dense, appressed, white pile; median groove very distinct; face entirely clothed with dense white hairs, which are continued to the chin, which bears a soft and rather sparse beard. Antennae entirely black, similar to those of *platyurus*. Proboscis elongate and slender with enlarged labella, usually about two and one-half times the length of the mouth opening, which is long and broad, with pale borders; palpi small, slender, dark brown.

Thorax greyish, clothed with short, dense and equal whitish hairs, somewhat shining white in front and on the sides, and which, viewed from the front, has a beautiful silvery-white sheen; posterior half of thorax with numerous intermixed black hairs, more conspicuous immediately anterior to the scutellum; bristles mainly pale brown, with intermixed black, the presutural bristles sometimes well marked; scutellum greyish, with similar tomentum to the thorax, and long, black, and a few intermixed brownish bristles, stronger on the margin; pleurae and

breast greyish, densely clothed with shining white hairs; squamae pale with a dense white fringe; halteres with blackish knobs.

Abdomen greyish, broad and rounded, clothed with dense, grey, appressed, and grey and white erect hairs, the latter more conspicuous on the third and fourth segments; posterior border of second segment with a band of dense, black hairs; apical segments with a dense tuft of long black hairs, divided at the extreme apex by some whitish or greyish hairs; bristles black, rather weak and small, much longer and stronger towards the apex, where there may be a few brown bristles intermixed; venter grey, densely white pollinose.

Legs: Coxae dark grey, basal half of femora, apices of femora and tibiae, and all apical tarsi black; rest of femora and tibiae somewhat brownish, the hind femora and tibiae darker, and all femora paler beneath; coxae and femora beneath with long white hairs; femora and tibiae with white scales, though the femora sometimes appear to be yellow-scaled above, and in certain lights the scales on the tibiae appear golden; fore femora with two, middle femora with about five, and hind femora with twelve long spines beneath; fore tibiae with usually four long black spines on the apical half, the spines being much longer and stronger than the remaining spines, and partly hidden by dense black and white or grey hairs, the latter appearing as a definite encircling band; two of the apical spines of the fore tibiae, the inner and outer, are much prolonged, being very much longer than the other apical spines, the outer spine generally longer and more apparent.

Wings somewhat subhyaline, faintly brown at the base and along the fore margin; apical cross-vein of cell mc rarely equal to r-m.

♀. Generally larger than the male, the broad frons being clothed with dense white pile, with some erect brownish bristles and soft white hairs; fore tibiae never with prolonged spines at apex or with the strong black spines and accompanying black and white tomentum of the male; apical tuft of abdomen very dense and not divided at apex.

Length of body, 6-13 mm.; of wing, 5·5-12 mm.

Hab.—Queensland: Brisbane (August to September); N. S. Wales: Sydney, Woy Woy, Wentworth Falls (October); Victoria: Williamstown (October).

Systoechus sericans (Macquart).

Bombylius sericans, Macq., *Dipt. Exot.*, suppl. 4, 1850, 116; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 69.—*Systoechus pausarius*, Jaennicke, *Abhand. Senck. Nat. Ges.*, vi, 1867, 348; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 70.

This species is very similar in appearance to *albiceps*, but the black band across the abdomen appears rather narrower, and the dense black hairs at the apex are divided into two separate tufts. The femora are wholly black, and the tibiae rather dark. The main difference lies in the spines of the fore tibiae. The long, strongly developed spines on the apical half, with the accompanying black and white hairs, are not so well marked as in *albiceps*, and the spines at the apex are all of nearly equal length, the two inner and outer spines never becoming so long and strong.

There are 25 ♂, 5 ♀ in the series before me, many of which are in a more or less damaged condition. The tufts on the apex of the abdomen certainly appear distinctly separated, and the black band narrower. The difference in the development of the tibial spines, especially of those on the apex, and the wholly black

femora, form reliable characters for the separation of the two species. The pubescence of the body has also a faint tawny tinge.

The female, as in *albiceps*, does not possess the strongly developed spines of the fore tibiae, but may be recognized by the wholly black femora, and the separated tufts at the apex of the abdomen.

Length of body, 8-13 mm.; of wing, 7-12·5 mm.

Hab.—Queensland: Eidsvold (October), Chinchilla (October to September), Morven and Roma (September), Brisbane (September); W. Australia: Badgerly, Merredin (no date).

SYSTOECHUS CALLYNTHROPHORUS Schiner.

Systoechus callynthrophorus, Schiner, *Reise Nov.*, 1868, 137; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 70.—*Bombylius spinipes*, Thomson, *Eug. Resa*, Dipt., 1868, 488; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 70.

This species is closely related to both *albiceps* and *sericans*. From both it may be distinguished by the golden or pale reddish bristles, the intermixed reddish hairs, the band across the abdomen being mainly reddish, and the apical tuft with long intermixed red hairs. It agrees with *albiceps* in having the apical tuft separated at the extreme apex only, and in sometimes possessing long inner and outer apical spines on the fore tibiae, the outer spine usually being more prominent. The genital spines on the apical half of the fore tibiae are also present and, in addition, there are two rows of three very long, strong, and erect spines on the middle tibiae, which are accompanied by similar black and white hairs, though not so marked. These latter spines are always in two rows, though in some specimens, one of the rows contains two spines only. The legs have the femora and tibiae an almost unicolorous pale brownish or yellowish, the femora being at most black at the extreme bases only.

The fore and middle tibiae of the female lack the long strong spines of the male, and the apical tuft of the abdomen is wholly black.

Length of body, 8-11 mm.; of wing, 7-10·5 mm.

Hab.—N. S. Wales: Sydney and Woy Woy (September to October).

In his catalogue of the Australian Bombyliidae, G. H. Hardy (1921) identified the grey species, with the abdomen black banded and tufted, as *vetustus*, with which he placed *sericans*, *penicillatus*, *pausarius*, *callynthrophorus* and *spinipes* as synonyms. In the collections examined there were 57 ♂, 20 ♀, all of which were primarily placed under the name *vetustus*. A study of this material, however, revealed the presence of three distinct species, the main differences lying in the development of the spines of the fore and middle tibiae, in the colour of the femora and in the division or otherwise of the apical black tuft of the abdomen. The first character was found to be sexual and possessed by the males only, and for the separation of the females the other characters had to be utilized. Neither of these is very satisfactory, but at the present time I am unable to locate any more definite characters.

In view of the inadequacy of the original descriptions, it has been rather difficult to place the three species, *sericans*, *albiceps*, and *callynthrophorus*. The latter species and Thomson's *spinipes* are regarded as the species from Sydney with the reddish abdominal band, the yellowish legs, and reddish bristles, *callynthrophorus* taking precedence; *sericans* and *pausarius* are both described as possessing black femora and separated apical tufts. Here are placed the species from Southern and Western Queensland and Western Australia. The remaining

species, *albiceps*, is determined with *vetustus* and *penicillatus* as synonyms, as in the descriptions the femora are noted as brownish or partly brownish, and the bristles of the body, black.

SYSTOECHUS AUSTRALIS (Guérin).

Bombylius australis, Guérin, *Voy. Coq.*, Zool., pt. 2, 1830, 294; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 75.—*Systoechus australis*, Hardy, *Proc. Roy. Soc. Tasm.*, 1923, 84.

♂. Head mainly greyish, upper part of face and frons darker; occiput moderately convex, clothed with dense, equal, pale tawny hairs, with which are mingled some darker bristles; ocellar tubercle black, with some long dark hairs; eyes almost contiguous at a point immediately below the ocellar tubercle, their upper facets distinctly enlarged; frontal triangle of moderate size, clothed with appressed golden scales, and with a few pale golden hairs near the inner eye margins; face densely clothed with pale golden hairs, which become almost whitish on the chin, forming a somewhat sparse beard; the hairs on the mouth borders form a thin moustache, which does not extend the full length of the cheeks; oral opening rather broad, its borders pale yellowish. Antennae black, not as long as the head, the first segment with long pale golden hairs, much longer beneath, the third segment longer than the first two together, broadening medianly, thence tapering to a blunt apex, which is provided with a stout style. Proboscis black, usually about three times the length of the oral opening, slender, with rather enlarged labella; palpi small, slender, brownish.

Thorax blackish, with reddish calli, densely clothed with short, pale tawny hairs which, viewed from the front, have a pale golden or yellowish sheen; postalar calli with a tuft of black hairs; scutellum black, broadly reddish on the margin, with similar pubescence; bristles strong and dark brownish; pleurae and breast much paler haired, the mesopleural tuft somewhat tawny above; squamae brown with a pale yellowish fringe; halteres brown with yellow knobs.

Abdomen broad and rounded, somewhat dark greyish, faintly reddish on the sides of the two basal segments; the whole clothed with appressed pale golden scales and dense tawny hairs, which are more dense laterally, and somewhat paler apically; bristles strong, dark brown, forming complete rows on the hind borders of the segments; venter densely pale haired.

Legs with coxae blackish, femora, tibiae, and basal tarsi pale brownish or yellowish, the apical tarsi darker; coxae and femora beneath with long whitish hairs; otherwise clothed with whitish scales which, against the yellowish ground colour, appear pale golden; middle femora with few, hind femora with many strong spines beneath; pulvilli pale.

Wings yellowish at base and along fore margin to the apex of cell Sc; remainder of wing dark smoky, clearer towards apex and hind margin.

♀. Frons very broad at vertex, clothed with dark golden scales and some erect black and golden hairs.

Length of body, 10-14 mm.; of wing, 9·5-12 mm.

Hab.—Queensland: Stradbroke Is., Mt. Tambourine (September); N. S. Wales: National Park and Woodford (November), Barrington Tops (February), Sydney (December), Blue Mts. (January).

In two males from Woodford and Barrington Tops, N. S. Wales, the body pubescence is much duller than in the rest of the series and in one of these males (Barrington Tops) the basal half of the fore and middle tibiae is black.

SYSTOECHUS DISTINCTUS (Walker).

Bombylius distinctus, Walker, *Ins. Saund.*, Dipt., 1850, 201.—*Systoechus distinctus*, Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 70.

This species is very similar in general appearance to *australis*, but differs in several characters. The head is very broad, much broader than in *australis*, the eyes are contiguous for some distance below the ocellar tubercle, the abdomen is much broader, and the general body pubescence is much brighter, almost a golden colour. The wings are almost hyaline, yellowish at the base and along the fore margin for about two-thirds the length, in contrast to the dark smoky wings of *australis*.

Of this species I have only seen a single specimen, a male, from Medlow, N. S. Wales, January.

SYSTOECHUS RUBIDUS, n. sp.

♀. Head greyish, the frons somewhat darker; occiput moderately convex, clothed with appressed white scales and dense, short, pale brownish, almost whitish hairs, which appear still paler below; frons at the vertex, about one and one-half times the width of the ocellar tubercle, clothed with dense, appressed, golden scales and erect pale hairs; median furrow distinct; face densely covered with appressed, clear white hairs, which do not appear to extend the full length of the cheeks to the white beard below; oral opening small, though rather broad compared with its length, its borders very pale yellowish; ocellar tubercle rather large, very prominent, with some erect, long, pale hairs. Antennae shorter than the head, the two basal segments brownish, the first with long pale hairs; the third segment is of unusual shape, being longer than the first two segments together, broadly flattened from side to side, so that it is somewhat broadly hastate, and provided with a small but distinct style placed a little below the extreme apex. Proboscis black, brownish at base and beneath, about three times the length of the oral opening; palpi very short, hidden.

Thorax grey-black, clearer grey in front and on the sides, clothed with appressed, pale golden scales, and dense, short, very pale yellowish hairs which, viewed from the front, appear whitish; bristles inconspicuous, pale golden; scutellum tinged reddish, with similar tomentum and pale, thin, bristles; pleurae and breast grey, white haired; squamae pale yellowish with a white fringe; halteres with yellow knobs.

Abdomen short and oval, pale reddish, the basal segment and portions of segments two, three, and four, darker, the apical segments paler, clothed with pale yellowish hairs and appressed pale golden scales, the bristles much darker; venter yellowish with appressed white pile and numerous pale bristly hairs.

Legs yellowish, coxae and apical tarsi dark, clothed with white scales, the coxae and femora beneath with long white hairs; middle femora with about two, hind femora with about six long spines below; pulvilli pale; claws black.

Wings subhyaline, faintly yellowish at base and in cell Sc, clearer at apex and along hind margin.

Holotype ♂, Chinchilla, Q'land, November, 1926, A. P. Dodd; length of body, 3·5 mm.; of wing, 3 mm. Paratype ♀, Moonie River, N. S. Wales, 2nd November, A. P. Dodd. In the paratype the abdomen is somewhat conical, more yellowish-brown than red, the basal segments darker medianly.

Both the holotype and paratype are not in the best condition for description, but the shape of the third antennal segment is so outstanding among the species of the genus as to warrant a description.

The holotype is in the Queensland Museum.

SYSTOECHUS ALBOHIRTUS, n. sp.

♂. Head greyish, silver grey on occiput and chin; occiput slightly swollen, clothed with dense, long, white hairs, which become much thinner on the chin to form a sparse, short, white beard; ocellar tubercle black, with some erect whitish hairs; eyes almost contiguous below the ocellar tubercle for a short distance, the width of the frons at the narrowest point being by no means as broad as the fore ocellus; upper and inner facets little enlarged; frontal triangle of moderate size, clothed with dense, appressed, white scales, face rather narrow, little projecting, clothed with dense white hairs, which do not appear to cover the basal portion of the cheeks; mouth opening rather narrow, with pale yellow borders. Antennae about as long as the head, the two basal segments reddish, the third darker, almost black; first segment with long white hairs, longer below; second about half the length of the first; third a little longer than the first two segments together, somewhat elongate oval in shape, broadest medianly, the style spine-like, very minute but distinct, placed a little below the extreme apex. Proboscis long, slender, about three times the length of the oral opening; palpi short, slender, yellowish.

Thorax blackish, grey laterally, clothed with appressed, white scales and dense, white hairs; bristles whitish, not conspicuous; pleurae and breast greyish, densely white haired; scutellum grey, with similar tomentum, the bristles longer and more easily seen; squamae whitish with a white fringe; halteres with pale yellow knobs.

Abdomen somewhat greyish, much longer than broad, clothed with appressed white scales and dense, white hairs, longest laterally; bristles whitish, not outstanding among the dense white hairs; venter white haired.

Legs yellowish, coxae, fore femora at base, and apical tarsi darker, the whole with white scales, the coxae and femora below with long white hairs; hind femora only with long spines below (spines beneath middle femora possibly broken off); pulvilli pale; claws black.

Wings hyaline; apical cross-vein of cell mc not equal to vein r-m, so that mc is somewhat acute at end.

♀. Similar to male, but frons very broad, clothed with dense white scales and some erect white hairs.

Holotype ♂, labelled South Australia only; length of body, 9 mm.; of wing, 8·5 mm. Allotype ♀, labelled South Australia only; length of body, 9·5 mm.; of wing, 8 mm.

No paratypes are known, the holotype and allotype being from the collection of the South Australian Museum. The species is outstanding on account of the unicolorous and dense, clear white pubescence, and the completely hyaline wings.

The holotype and allotype are in South Australian Museum.

SYSTOECHUS PALLIDUS, n. sp.

♂. Head mainly greyish, the face and frons darker; occiput moderately convex, clothed with dense, short, equal, pale golden hairs, somewhat paler below; ocellar tubercle large, black, with some bristly, blackish hairs; eyes contiguous imme-

diately below ocellar tubercle for a short distance, their upper facets little enlarged; frontal triangle of moderate size, clothed with appressed, golden scales; median furrow distinct; face becoming grey dusted towards the chin, covered with long, black, bristly hairs, with a pale golden moustache, which does not extend to the sparse, white beard below; mouth opening somewhat short and broad, its borders pale yellowish. Antennae almost entirely black, not as long as head, the first segment with long black hairs, the third longer than the first and second together, the basal half broadened and somewhat oval, the apical half, linear, provided with small spine-like style, placed a little below the extreme apex. Proboscis black, rather stout, about three times the length of the oral opening, its labella rather enlarged; palpi black, slender, about one-third the length of the proboscis.

Thorax black, grey on the sides, clothed with appressed pale golden scales and dense, short, equal, pale yellowish hairs, the whole viewed from the front with a somewhat whitish sheen; pleurae and breast grey, with dense white hairs, the mesopleural tuft stained yellowish above; bristles weak and small, not conspicuous; scutellum dark brownish, with similar hairs and scales, and with numerous long, pale, weak, and stronger, darker intermixed bristles; squamae pale with a pale fringe, which sometimes appears whitish; halteres pale brown with yellow knobs.

Abdomen somewhat obconical, much longer than broad, dark brown with small lateral pale reddish areas to each segment, the areas decreasing in size apically; dorsum clothed with hairs and appressed scales, similar to those on the thorax, the hairs rather more dull, and paler laterally and towards the apex, and the scales longer and paler apically; bristles numerous, long, blackish; venter grey, densely white haired.

Legs with coxae grey, the remainder, except for the darker apical tibiae, pale yellow, clothed with white scales, the coxae and femora below with long white hairs; middle femora with three short, hind femora with five to seven long spines beneath; pulvilli pale.

Wings yellow at base and along fore margin to the apex of cell Sc, the remainder smoky, clearing to hind margin and apex, so that both these portions of the wing are almost hyaline; veins heavily marked; venation normal; cell mc sharply acute and very broad basally.

Holotype ♂, Brisbane, Q'land, 15th August, 1927, F. Roberts; length of body, 8 mm.; of wing, 6·5 mm. Paratypes: 6 ♂, Brisbane, August to October, F. Roberts; 2 ♀, Brisbane, August, J. Mann.

Among the series of this species is a female (Blackheath, 1st February, 1926, I. M. Mackerras) which is in too bad a condition to be made an allotype. As far as an examination will allow, the broad frons shows dark golden scales and long black hairs, the specimen being otherwise similar to the male.

The holotype is in the Queensland Museum.

Systoechus flavovillosus, n. sp.

♂. Head grey; occiput moderately convex, clothed with dense, bright yellow hairs, which become much paler below; ocellar tubercle black, with some long, black, bristly hairs; eyes contiguous for a short distance below the ocellar tubercle, their upper facets little enlarged; frontal triangle of moderate size, clothed with appressed, golden scales; median groove very distinct; face barely projecting, clothed with black bristly hairs, the moustache thin and very pale golden, extending almost the full length of the cheeks to the sparse, whitish beard below; oral

opening short and rather narrow, its borders pale. Antennae entirely black, the first segment with long black hairs, the third longer than the first two segments together, its basal half broadening and somewhat ovate, thence gradually tapering to a not very slender apex; style minute, spine-like, placed somewhat subapically. Proboscis black, rather short and not so very slender, about two and one-half times the length of the oral opening; palpi slender, blackish, about one-third the length of the proboscis.

Thorax black, somewhat greyish laterally, clothed with appressed, shining golden scales and short, dense and equal, bright yellow hairs; pleurae and breast greyish, much paler haired; bristles thin, not conspicuous; scutellum black, clothed like the thorax, but with more conspicuous pale golden bristles; squamae pale with a very pale yellow fringe; halteres pale brownish with yellow knobs.

Abdomen rather short and rotund, black, at most tinged reddish on the extreme lateral margins of the basal segments; dorsum clothed with appressed golden scales and dense bright yellow hairs; bristles very pale golden, very long and forming complete rows on the hind borders of the segments; venter grey, with very pale shining, yellow appressed pile and longer, pale bristly hairs.

Legs mainly yellow, the coxae grey, apical tarsi of fore and middle legs, all tarsi and apex of tibiae of hind legs brownish, the femora and tibiae clothed with pale golden scales, which appear to be somewhat whitish on the femora beneath; coxae and femora below, with long pale hairs; hind femora with about five long spines below; middle femora without any apparent spines below; pulvilli pale.

Wings subhyaline, yellowish at base and along the fore margin to the apex of the cell Sc; venation normal; R_{2+3} moderately curved at apex to meet the costa at an obtuse angle.

Holotype ♂, Meringa, Nth. Q'land, 17th November, 1926, Goldfinch; length of body, 7·5 mm.; of wing, 7 mm.

In the female the frons is rather narrow at the vertex of the head, being about one and one-half times the width of the ocellar tubercle, clothed with golden scales and erect black bristly hairs; face with silver-white hairs; pleurae and breast white haired, the mesopleural tuft pale yellow; abdomen black, the segments with small pale reddish-brown lateral areas, larger on the basal segments and decreasing in size apically.

Allotype ♀, Meringa, 17th November, 1926, Goldfinch. Paratypes, 2 ♀, same data, in the collection of Dr. I. M. Mackerras.

The difference in the ground colour of the abdomen in the male and female is rather peculiar. In the male, the abdomen is almost wholly black, the basal segments tinged pale reddish laterally. In the female the colour is similar to that of *pallidus*, the pale reddish lateral areas being very distinct. It is possible that the condition of the abdomen as seen in the holotype is a variation, the usual colour being identical with that of the female.

The holotype and allotype are in the Macleay Museum.

Systoechus cinctiventris, n. sp.

♂. Head mainly greyish; occiput little convex, clothed with dense, equal, pale yellow hairs, which become more whitish below; ocellar tubercle black, with long pale hairs; eyes contiguous for a short distance below the ocellar tubercle, their upper facets enlarged; frontal triangle small, clothed with appressed, pale golden yellow tomentum, the median groove very distinct; face clothed with short, dense white hairs, stained yellowish below antennae, the moustache white, not

extending to the white beard below. Antennae black, as long as the head, the first segment with long, very pale yellowish hairs, the third about one and one-half times the length of the first two segments together, of similar shape to that of *pallidus*; the style spine-like, and placed somewhat subapically. Proboscis black, slender, about three times the length of the oral opening; palpi slender, one-fourth the length of the proboscis.

Thorax dark brownish-black, greyish laterally, clothed with appressed golden scales and dense, short and equal yellowish hairs which, when viewed from the front, appear paler laterally; pleurae and breast grey, white haired, the mesopleural tuft faintly yellow above; scutellum black, with golden scales and thin, pale golden bristles; squamae pale with a pale golden fringe; halteres with pale yellow knobs.

Abdomen somewhat obconical, black, with yellow lateral areas to each of the segments, those on the sides of the second and third segments very large, the black colour thus appearing as a broad dorsal stripe, continued from base to apex, and denticulated at the borders of the segments, this denticulation being particularly noticeable on the second, third and fourth segments; dorsum clothed with golden scales and dense pale yellowish hairs; bristles very weak, pale, forming complete rows on the hind borders of the segments; venter grey, clothed with pale yellowish tomentum and pale bristly hairs.

Legs mainly pale yellow, coxae grey, apical tarsi of fore and middle legs and all hind legs darker, clothed with white scales, the coxae and femora below with long white hairs; hind femora with about six long spines below; pulvilli pale.

Wings yellowish at base and along fore margin to apex of cell Sc, the remainder of the wing pale smoky, clearer at apex and along the hind margin; venation normal.

Holotype ♂, Chinchilla, Q'land, 14th November, B. Smith; length of body, 8 mm.; of wing, 7·5 mm.

♀. Frons broad with dark golden scales and black hairs; wings clearer than in male.

Allotype ♀, Brisbane, Q'land, 8th August, 1927, J. Mann. Paratypes: 6 ♂, Chinchilla, Q'land, 14th November, 1926, B. Smith; 1 ♂, Chinchilla, January, 1928, A. P. Dodd; 1 ♂, Goondiwindi, January, 1928, F. Roberts.

This species is very similar to *pallidus*, but may be distinguished by the brighter pubescence, the white hairs of the face, the larger pale yellowish lateral areas of the abdomen, and by the clearer infuscation of the wing.

The holotype and allotype are in the Queensland Museum.

Systoechus leucopygus v. d. Wulp.

Systoechus leucopygus, v. d. Wulp. *Notes Leyden Mus.*, vii, 1883, 86; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 70.

Nigricans, flavo-hirtus, mento, pectore anoque albo-hirtus; antennis rostroque nigris; pedibus luteis; alis cinereis, basi et costa testaceis; male, long 10½ mm.

General appearance like a European species of *Bombylius*. Blackish, covered with a very dense yellow pilosity, which becomes fulvous on the collar and has silvery-white reflections on the last abdominal segment; front small, trigonal; face short, both with a sericeous pale yellow pile; beard and hairs on the breast and pleurae, white. Antennae black; the first segment cylindrical, the second short, the third a little longer than the previous joints together, subulate. Rostrum black, as long as the thorax. Legs yellow, with small bristles, those on the front

legs very short. Halteres reddish-yellow. Wings greyish, at the base and along the costa as far as two-thirds of its length with a brownish white tinge.

A male from Adelaide (Felder).

This species has not been recognized among the material examined.

Genus Sisyromyia White.

Sisyromyia, White, *Proc. Roy. Soc. Tasm.*, 1916, 197; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 70; 1923, 84.

Genotype, *Bombylius auratus*, Walker, by original designation.

Head very broad, about equal in breadth to the thorax; occiput somewhat flattened above, little convex below; eyes contiguous or almost so in the male, widely separated in the female; frontal triangle rather large; face very broad, little projecting between the eyes, slightly broadening to the chin; cheeks comparatively broad. Antennae approximated at base, the first segment slender and much longer than the second, the third as long as or much longer than the first two together, somewhat varying in form, usually rather linear with a rounded apex with a minute apical style, and some long bristly hairs at the apex. Proboscis long, frequently thickened, with the labella sometimes much expanded; palpi slender, usually small.

Thorax broad, slightly arched, with the postalar bristles very weak; scutellum broad and semicircular, with very long bristles or bristly hairs.

Abdomen curved, usually short and very broad, equal in breadth to or broader than the thorax, with very long bristly hairs.

Legs slender, the hind legs much longer, hind femora with two rows of strong spines beneath, one of the rows very short; spines on fore tibiae very short; femora with long hairs below.

Wings with well developed lobes and alulae; R_{2+3} curved apically, at most to meet the costa at a right angle; cells R_3 and R_4 never divided; cell R_5 open; vein r-m placed well before the middle of cell mc, so that cells R and M are of an approximately equal length; cell Cu open.

Range.—Australia.

This genus is confined to Australia, and as far as is known contains six species, none of which is new. Nothing is known of their habits or life histories.

Distribution.—Very few specimens of the various species have been collected, so the records of the habitat, etc., are rather scanty. New South Wales possesses three species, *decorata*, *albavitta* and *aurata*. The former, as far as the records show, is confined to that State, though it was originally described from Western Australia. The other two species are more widely distributed, *albavitta* occurring in Western Australia and Queensland and *aurata* in Western Australia and Tasmania. Of the remaining species, *limbatus* is known from South and Western Australia, *brevirostris* from Tasmania, and *tetratricha* from Western Australia, respectively.

Key to the Species of Sisyromyia.

1. Wings spotted ..... *limbata* Bigot
   Wings not spotted 2
2. Thorax encircled with white hairs ..... *decorata* Walker
   Thorax without such white hairs 3
3. Apex of abdomen with a thick tuft of black pubescence on each side ..... *tetratricha* Walker
   Apex of abdomen without such tufts 4

4. Abdomen with a yellow or white central stripe 5
Abdomen without a central stripe ..... *brevirostris* Macquart
5. Pubescence golden yellow ..... *aurata* Walker
Pubescence reddish ..... *albavitta* Macquart

Sisyromyia limbata (Bigot).

Sparnopolius limbatus, Bigot, *Ann. Soc. ent. France* (7), lxi, 1892, 369.—*Dischistus limbatus*, Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 69.

♂. Head mainly grey, frons and upper portion of face rather darker; occiput dark brown above, clothed with dense, pale brown and some intermixed, longer black hairs, the hairs becoming paler below; eyes almost contiguous for a short distance below the ocellar tubercle; ocellar tubercle black, with some long black hairs; frons between the eyes exceedingly narrow, at its narrowest point being no wider than the fore ocellus; frontal triangle rather broad, clothed with appressed, pale shining pile; median groove distinct; face clothed with long, black, bristly and pale brown hairs, the latter becoming white on the cheeks and chin, and the former more or less encircling the pale brown hairs above. Antennae with the first two segments greyish, the third black; first segment with long black hairs, third longer by one-half than the first two together, constricted at base, somewhat linear in shape, the apex with five or six long black bristly hairs; style very minute. Proboscis rather short and slender, the labella not much enlarged; palpi very small, hidden.

Thorax dark brown, greyish laterally, clothed with short, dense, brownish, and some intermixed black hairs, the latter more apparent posteriorly; on each side there is a stripe of short dense white hairs, which extends for the full length above the wing insertions; pleurae and breast grey, white haired, mesopleural tuft brownish above; scutellum dark brown, with a basal band of appressed, silver-white hairs, which is contiguous on either side with the lateral stripes of the thorax; bristles brownish and black; squamae pale brown with a whitish fringe; halteres with yellow-brown knobs.

Abdomen short and broad, not as long as its greatest width, and pointed apically; dark brown, clothed with pale brown hairs, very long and dense on the sides of the first and second segments; remaining segments with more apparent appressed, golden brown scales, and laterally with sparse, clear white tomentum, the whole bearing long thin black bristly hairs; from the second segment to the extreme apex, there extends a stripe of silver white scales; venter white haired, longer and stained brownish towards the apex.

Legs somewhat yellowish, with grey coxae, and dark apical tarsi; femora with white scales, somewhat golden above, and short white and longer black hairs below; pulvilli pale.

Wings yellow at base and along fore margin, the rest smoky, rather clearer at the apex and along the hind margin, containing six suffused spots, placed on the cross-veins between M and M_4, mc and M_1, on im, where it joins M_{3+4}, near the origin of R_4 with R_{4+5}, and more faintly on the curves of R_{2+3} and R_4; R_{2+3} little curved, meeting the costa at an obtuse angle.

♀. Frons extremely broad, clothed with long black bristly hairs, and some appressed pale scales.

Length of body, 8 mm.; of wing, 7·2 mm.

Hab.—South Australia: Port Augusta (August); Western Australia: Eradu.

The description is taken from a solitary pair in the South Australian Museum. Neither the male nor female is in the best condition, and the colour of the hairs

of the face in both sexes is somewhat doubtful. In the male there are traces of white hairs on the posterior part of the thorax. However, the species may easily be recognized by the encircling white stripe of the thorax, the white stripe of the abdomen in conjunction with the spotted wings.

Hardy was uncertain of the position of this species, and placed it in the genus *Dischistus*.

SISYROMYIA ALBAVITTA (Macquart).

Bombylius albavitta, Macquart, *Dipt. Exot.*, suppl. 4, 1850, 117; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 71; 1923, 85.

♂. Head mainly grey, frons and upper part of face darker; occiput clothed with dense, short, reddish hairs above, much paler and rather shorter below; eyes separated by a very narrow streak, not broader than the fore ocellus; ocellar tubercle black with some long, black, bristly hairs; frontal triangle rather large, clothed with dense, appressed golden scales; face with golden pile and long, black, bristly hairs, the latter placed mainly above and close to the inner eye margins and immediately beneath the antennae. Antennae mainly black, the first two segments somewhat greyish; first segment with long black hairs, third constricted at base, broader medianly, longer than the first two segments together, with a minute apical style, and some long, black, bristly subapical hairs. Proboscis entirely black, rather stout, with expanded labella, about twice the length of the oral opening; palpi very slender, pale brown, about one-fourth, or little less, the length of the proboscis.

Thorax black, clothed with shining appressed golden scales, and dense, short, equal, reddish hairs; pleurae and breast paler haired, the mesopleural tuft reddish; scutellum dark, with similar golden scales, longer reddish hairs, and very thin, reddish bristles or bristly hairs; squamae pale brown with a pale reddish fringe; halteres with reddish-brown knobs.

Abdomen curved, short and broad, usually hardly as long as its greatest width, blackish, clothed with appressed golden scales and long reddish hairs, very dense apically and laterally; bristles very long, black, with some paler bristles intermixed; from the second segment to the apex there runs a rather broad median stripe of shining whitish scales; venter densely pale haired, reddish apically.

Legs reddish, coxae grey, clothed with reddish scales; femora below and coxae with long pale and some black hairs; hind femora with long strong spines below; middle femora with few spines below.

Wings somewhat smoky, yellowish at base and along fore margin for about two-thirds the length; R_{2+3} curved apically so as to meet the costa at an obtuse angle; cell mc very long and rather narrow.

♀. Frons very broad, clothed with golden scales and long black bristly hairs.

Length of body, 10-11·5 mm.; of wing, 11·5-14 mm.

Hab.—Queensland: Mt. Tambourine (January); N. S. Wales: Mt. Kosciusko, Sydney (February); W. Australia: King George's Sound.

This species was regarded by Hardy as a form of *aurata*. The species appears to me to be distinct, the differences lying in the palpi, the curvature of the vein R_{2+3} and of course, in the colour of the pubescence. In *albavitta*, the palpi are rather shorter and more slender, not being swollen apically as in *aurata*; in *aurata* R_{2+3} is always so curved apically as to meet the costa at a right angle, whereas in *albavitta*, the curvature is much less, the vein meeting the costa at an obtuse angle.

I have seen in the collection of the Queensland Museum a large specimen very similar in colouration to *albavitta*. In this specimen the proboscis is of an outstanding length, being about as long as the fly itself. Its habitat is given as King George's Sound, W. Australia, and in all probability it is a distinct species.

SISYROMYIA DECORATA (Walker).

Bombylius decoratus, Walker, *List Dipt. Brit. Mus.*, ii, 1849, 291.—*Sisyromyia decoratus*, Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 71.—*Bombylius scutellaris*, Thomson, *Eug. Resa*, Dipt., 1868, 488; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 71.

♀. Head grey, the face with a narrow brown horizontal stripe immediately below antennae, and including their base; occiput clothed with pale reddish hairs above and on each side of the vertex, much paler laterally, almost whitish below; frons very broad at vertex, with erect, black, bristly hairs, on each side and above, and some appressed golden scales; face clothed with short pale golden hairs, with erect, black, bristly hairs encircling, and placed near the inner eye margins and immediately below the antennae; cheeks and chin white haired. Antennae with the basal segments greyish, the third black; third segment constricted at base, somewhat linear in shape, with a minute apical style, and some long, black, bristly, apical hairs. Proboscis black, slender, the labella little enlarged, a little more than twice the length of the oral opening; palpi very small and slender, apex with longer hairs.

Thorax grey, with two broad dark brown admedian stripes and a narrow median stripe, so that the thorax appears dark brown with front and sides grey, and two narrow admedian grey stripes, the dark brown portions clothed with appressed reddish golden scales and short, dense, reddish hairs, the grey, with white scales and short, white hairs, the thorax thus appearing with reddish hairs, with two lateral and two admedian white stripes; pleurae and breast grey, white haired; mesopleural tuft reddish above; scutellum blackish, with a basal stripe of white hairs, contiguous with the lateral white stripes of the thorax, otherwise clothed with reddish hairs and provided with long, thin, black, bristly hairs; squamae with a sparse pale fringe; halteres with somewhat yellowish knobs.

Abdomen short and very broad, about as long as its greatest width, the basal segment with short, erect, white hairs; remainder with appressed dark golden scales, white scales laterally, and reddish hairs, the latter forming reddish tufts on the sides, intermixed with longer, black, bristly hairs, and some pale, almost whitish hairs; apex with two long tufts of reddish and intermixed black hairs on each side; bristles very long, thin, black; from base to apex there runs a median stripe of silver white scales; venter with pale appressed hairs, longer and reddish and intermixed with black, bristly hairs laterally.

Legs somewhat brownish, coxae grey, hind legs darker, almost reddish; femora appear clothed with pale golden scales, which are intermixed with white scales, more so beneath; femora beneath with long white and longer black hairs.

Wings with costal cell yellow, dark brown from base to apex, and for nearly half the breadth, the colour being somewhat suffused apically; inner margin of coloured area very irregular, occupying all cell M, one-half of cell R_5, thence across to the bifurcation of R_4 and R_5, leaving a large clear area in cell R_3; R_{2+3} curved as to meet costa at an obtuse angle; R_4 with an appendix.

Length of body 9 mm.; of wing, 10 mm.

Hab.—N. S. Wales: Medlow Bath and Sydney (October).

The description is taken from a solitary female. The thorax is rather rubbed and the four white stripes are only traceable.

SISYROMYIA AURATA (Walker).

Bombylius auratus, Walker, *List Dipt. Brit. Mus.*, ii, 1849, 289.—*Sisyromyia auratus*, White, *Proc. Roy. Soc. Tasm.*, 1916, 198; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 71; 1923, 85.—*Bombylius rutilus*, Walker, *List Dipt. Brit. Mus.*, 1849, 289.—*Sisyromyia rutilus*, Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 72.—*Bombylius crassirostris*, Macquart, *Dipt. Exot.*, suppl. 4, 1850, 117.—*Bombylius loewii*, Jaennicke, *Abh. Senck. Nat. Ges.*, vi, 1867, 345.—*Bombylius pycnorhynchus*, Thomson, *Eug. Resa*, Dipt., 1868, 486; *Bombylius lobalis*, Thomson, *Eug. Resa*, Dipt., 1868, 487.

♂. Head mainly grey; occiput clothed with dense, short, golden yellow hairs, somewhat paler below; eyes separated by a narrow streak, not broader than the fore ocellus; ocellar tubercle with some long black, bristly hairs; frontal triangle rather large, clothed with dense, appressed, golden yellow scales; median groove distinct; face densely clothed with yellow hairs, paler on the cheeks and chin, with numerous long, erect, black, bristly hairs, which extend from immediately beneath the antennae along the inner eye margins for about two-thirds the length of the cheeks; mouth opening long and somewhat narrow, its borders brownish. Antennae black, the first segment with long black hairs, the third, much longer than the first and second together, strap-shaped, with a minute apical style and some long, black, bristly hairs a little below the apex. Proboscis black, rather stout, labella much enlarged; palpi rather stout, somewhat swollen apically about one-third the length of the proboscis.

Thorax black, clothed with appressed golden scales and short, dense, golden yellow hairs, with a few black hairs intermixed; pleurae and breast grey with dense pale golden yellow hairs, the mesopleural tuft somewhat darker above; scutellum brownish, darker basally, with appressed golden scales and long yellow and intermixed black, bristly hairs; squamae brownish with a pale golden yellow fringe; halteres with brownish-red knobs.

Abdomen very short and broad, usually much curved, rounded and at most as long as its greatest width; dorsum with appressed golden scales and long golden yellow hairs, longer and denser laterally, the whole with long, black, bristly hairs; extending the full length is a broad median stripe of bright yellow scales, the golden scales rather sparse on each side and more confined to the lateral portions of the segments; venter densely paler haired, somewhat darker laterally.

Legs mainly reddish-yellow or yellowish, the apical tarsi of fore and middle legs and all tarsi of hind legs dark; middle femora with about six, hind femora with ten to twelve stout bristles beneath; spines on fore tibiae rather small, well developed on posterior tibiae.

Wings somewhat smoky, with the base and the fore margin for about two-thirds its length yellow; R_{2+3} much curved at apex, so that it meets the costa at a right angle; cell mc rather long and narrow.

♀. Frons very broad, clothed with golden scales and long black, bristly hairs, otherwise similar to male.

Length of body, 9-12 mm.; of wing, 12-15·5 mm.

Hab.—N. S. Wales: Barrington Tops, and Mt. Kosciusko (February), National Park (1st March, 1926); W. Australia: Swan River (December); Tasmania: Zeehan (January).

To the synonymy erected by Hardy, I have added *Bombylius rutilus* Walk.

SISYROMYIA BREVIROSTRIS (Macquart).

Bombylius brevirostris, Macquart, *Dipt. Exot.*, suppl. 4, 1850, 119; (?) Walker, *Ins. Saund. Dipt.*, 1850, 202.—*Sisyromyia brevirostris*, White, *Proc. Roy. Soc. Tasm.*, 1916, 199; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 71; 1923, 85.—*Systoechus eulabiatus*, Bigot, *Ann. Soc. ent. France* (7), lxi, 1892, 366.

This species is not represented in the material under revision, but as White determined and described it, I am rewriting his description.

"♂. Face covered with pale yellow tomentum, front with pale golden pubescence. Proboscis black, nearly three times the length of the head, with the tip slightly inflated. Antennae black, the first joint about three times the length of the second, and bearing long yellow hairs, the third about equal in length to the first two together, of a slender strap shape, with rounded style like apex. Eyes joined. Thorax and abdomen of a dull black ground colour, which in fresh specimens is entirely covered with very long, furry, yellow pubescence, but this becomes very easily detached. Legs very slender, femora black, with pale yellow pubescence, anterior and middle tibiae red, posterior tibiae brown, the whole bearing minute bristles; tarsi black. Wings hyaline, with the fore margin brownish.

Female resembles the male, but the eyes are very widely separated, and the pubescence of the face and front paler.

This species seems to be very local, but is probably common where it occurs. The males hover in the air in the bright sunshine at a height of some five feet from the ground, but should a cold wind arise they disappear completely. It occurs during February".

Length, ♂, 6-7 mm.; ♀, 6·5 mm.

Hab.—Bagdad, Tasmania.

White has fortunately illustrated the wing of this species, and the venation is typical of the genus. The species is peculiar in that the third antennal segment does not possess the apical bristly hairs and the abdomen the central dorsal stripe so characteristic of the other four species. It is unfortunate that the species is not represented in any collection, as it is probable that *brevirostris* belongs to the genus *Sparnopolius*, which is very closely allied to *Sisyromyia*. The venation of the two genera is identical but *Sparnopolius* may be distinguished by the differently shaped antennae, the third segment being devoid of the apical hairs, so characteristic of *Sisyromyia*, and the more or less conical abdomen.

SISYROMYIA TETRATRICHA (Walker).

Bombylius tetratrichus, Walker, *List Dipt. Brit. Mus.*, ii, 1849, 291.—*Sisyromyia tetratrichus*, Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 72; 1923, 84.

There is a single specimen of this species in the collection of the Queensland Museum, a female. This specimen is in a very bad condition, but an examination shows it to be clothed mainly with yellowish hairs, the abdomen with a tuft of black hairs on each side, and the wings greyish, faintly brownish at the base and along the fore margin for about two-thirds the length.

The habitat is given as Hamel, West Australia.

SISYROMYIA PRIMOGENITA (Walker).

Bombylius primogenitus, Walker, *List Dipt. Brit. Mus.*, ii, 1849, 292.—*Sisyromyia primogenitus*, Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 72; 1923, 85.

Mas. Niger, pilis ferrugineis vestitus, capite pilis albis fulvis nigrisque ornato, antennis nigris, pedibus fulvis, femoribus basi nigris, tarsis piceis, alis subcinereis basi et ad costam fuscis.

Body black; head rather broad, clothed with tawny hairs behind, with black hairs on the crown, and with white hairs on the front and beneath; eyes red; mouth rather shorter than the chest; feelers black; second joint not one-third the length of the first; third joint very slightly tapering from the base to the tip, longer than the first and second; chest and breast clothed with bright ferruginous hairs; breast clothed with hoary hairs; abdomen clothed with black hairs at the tip; legs tawny and clothed with short tawny bristles; thighs towards the base and hips black, clothed with long white hairs; feet piceous towards the tips; wings pale grey, brown at the base and along the fore border to the tip, and for one-third the breadth; wing ribs and veins black, the latter black towards the tips; poisers bright yellow. Length of the body, 3 lines; of the wings, 6 lines.

Swan River.

The above species has not been recognized. White compared it with Macquart's *brevirostris*, remarking that the costa was more broadly brown and did not extend to the apex of the wing.

Genus Anastoechus Osten Sacken.

Anastoechus, Osten Sacken, *Bull. Unit. States Geol. Surv.*, iii, 1877, 251.

Genotype, *Bombylius nitidulus*, F., by original designation.

Head about as broad as thorax; face not projecting between the eyes, the mouth borders, the cheeks and the eyes being almost on the same level, clothed with dense, long and erect hairs, which conceal its outlines and the basal segments of the antennae. Eyes small, separated in the male by an interval at the vertex; a distinct line separates the upper and larger facets from the smaller and lower ones. Antennae usually longer than the head, the first segment very long, the second short, the third more distinctly attenuated than in *Systoechus*, the dilatation being removed further towards the middle, the slender apical half more attenuated.

Thorax and abdomen similar to *Systoechus*.

Wings with the venation of *Systoechus*, but the cell mc is very much broader in relation to its length.

Range.—World-wide.

I have had to content myself with describing three species of this genus. In the material examined there are possibly at least five species which fall into this genus, but the material is neither sufficient in numbers nor in good enough condition for any further descriptions. They are all closely allied and somewhat difficult to separate, hence the need of more material.

Distribution.—Two species, *perspicuus* and *annexus*, appear confined to Western Australia, and one, *bifrons*, to New South Wales, though this latter species possibly occurs in Queensland also. Of the species not yet described, all are from Western Australia.

Key to the Species of Anastoechus.

1. Body clothed mainly with white pubescence ..... *perspicuus*, n. sp.
   Body clothed with brown or golden pubescence 2
2. Pleurae and breast mainly white haired; pubescence bright yellow or golden, a small species ..... *bifrons* Walker
   Pleurae and breast mainly brown haired; pubescence mainly brown or tawny, a medium-sized species ..... *annexus*, n. sp.

ANASTOECHUS PERSPICUUS, n. sp.

♂. Head mainly dark grey; occiput, more convex laterally and below, clothed with silvery scales and dense, long, white hairs; frons very narrow between the closely approximated eyes, its width at the narrowest point hardly equal to the fore ocellus; frontal triangle covered with white pile; face clothed with dense, erect, white hairs, encircling which is a row of black hairs, which are continued along the inner eye margins to about the level of the upper mouth borders. Proboscis black, rather short, with little enlarged labella; palpi hidden. Ocellar tubercle black, with some long, black hairs. Antennae entirely black, the first segment with long black hairs, the third about as long as the first and second together, with a minute apical style.

Thorax blackish, clothed with dense white hairs, with which are intermixed many bristly, black hairs; pleurae dark grey, with similar white hairs; scutellum dark grey, with white hairs and long, whitish bristles; squamae pale brown with a long yellowish fringe; halteres with yellow knobs.

Abdomen black, somewhat oval, clothed with dense white hairs, longest and most dense laterally and apically; bristles pale, not conspicuous; venter greyish, white pollinose.

Legs mainly black, the coxae greyish, the apices of the femora narrowly reddish, and the tibiae yellowish, clothed with white scales, the femora with long white hairs beneath, the scales of the tibiae appearing golden against the yellow ground colour.

Wings brownish at the base and along the fore margin to the apex of cell Sc, the colour descending in a curve to the apex of Cu, so that a little more than the basal half is suffused with brown, the remainder being sub-hyaline.

Length of body, 7·5 mm.; of wing, 6 mm.

Holotype male, Beverley, Western Australia; paratypes, 2 males, Capel River, W. Australia, W. D. Dodd.

The holotype is in the South Australian Museum.

ANASTOECHUS BIFRONS (Walker).

Choristus bifrons, Walker, *Ins. Saund. Dipt.*, 1850, 198, Pl. v, fig. 5.—*Systoechus bifrons*, Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 70.

♂. Head dark grey; occiput clothed with shining yellow hairs above, becoming white to the dense beard below; frons very narrow between the eyes, at its narrowest point hardly equal in breadth to the fore ocellus; ocellar tubercle black, with some long black hairs; frontal triangle rather large, clothed with dense, erect, black hairs, which are continued along the inner eye margins almost to the chin below; face covered with dense, erect, white hairs. Proboscis rather stout, black, with enlarged labella; palpi short and slender, black. Antennae entirely black, the first segment with long black hairs, the third about as long as the first and second together, with a minute apical style.

Thorax black, covered with dense, yellow or brownish hairs, rather darker laterally; scutellum with similar hairs and long, thin, pale bristles; pleurae and breast white haired, the mesopleural tuft yellowish above; squamae dark, with a pale yellow fringe; halteres yellow.

Abdomen black, covered with long yellow hairs, densest laterally and with intermixed paler hairs apically, so that the apical segments have a whitish sheen; venter white pollinose.

Legs mainly black, the femora white scaled, the tibiae with golden scales.

Wings suffused with dark brown from the base, the colour diluting, leaving the apex broadly sub-hyaline; R_{2+3} meets the costa at right angles.

Length of body, 6·5 mm.; of wing, 6 mm.

Hab.—N. S. Wales: National Park (September).

Two males collected by A. P. Dodd at Morven, Queensland, in September, are probably the same species, but the pubescence is much lighter in colour, being very pale yellowish.

The female is unknown.

ANASTOECHUS ANNEXUS, n. sp.

♂. Head with face and frons blackish, running to grey along the cheeks to the chin; occiput clothed with long brown and intermixed whitish hairs above, and short, clear white hairs to the dense, white beard below; laterally and contiguous with the hind eye-margins are some silvery scales; frons very narrow between the closely approximated eyes, at its narrowest point hardly equal in breadth to the fore ocellus; ocellar tubercle with some long, black hairs; frontal triangle rather large, clothed with dense, long and erect black hairs, which are continued along the inner eye-margins almost to the chin; face clothed with white hairs, of an almost equal length and density to the beard below. Antennae entirely black, the first segment about three times the length of the globular second, clothed with long, black hairs, the third about as long as the first and second together, with a minute apical style. Proboscis long and slender, black; palpi very thin, and small, black.

Thorax black, covered with short, dense, tawny hairs, and appressed, shining, golden scales, the hairs viewed from above appearing paler laterally; extending from the postalar callus to just above the wing base are some whitish hairs; bristles pale brown, not conspicuous; scutellum blackish, with similar hairs and long, thin, pale bristles; pleurae clothed with brown hairs, which become whitish from beneath the wing base to the base of the fore coxa.

Abdomen black, not very broad, clothed with long tawny and some intermixed paler hairs, the latter predominant apically, so that the apical segments have a whitish sheen; bristles black, and pale brownish to whitish; venter black, with appressed white scales and long, black, bristly hairs.

Legs mainly black, the femora with golden scales above and white scales and long pale hairs below; tibiae with golden scales; pulvilli pale.

Wings with the basal half dark brown, the apical half subhyaline, the edge of the colour extending from the apex of the cell C to the apex of the vein Cu_1, is gradually diluted, leaving the apical half of the wing somewhat smoky; R_{2+3} meets the costa at a right angle.

Length of body, 10·5 mm.; of wing, 10 mm.

Holotype male, Eradu, W. Australia, 8th September, 1926, E. W. Ferguson. Paratypes, 2 males, with similar data. There are also 4 males from Merredin, W. Australia, in the collection of L. J. Newman.

The holotype is in the collection of the Macleay Museum.

Genus BOMBYLIUS Linnaeus.

Bombylius, Linnaeus, *Syst. Nat.*, Edit. x, 1758, 606; White, *Proc. Roy. Soc. Tasm.*, 1916, 192; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 72; 1923, 84.

Genotype, *Bombylius major* Linn., by designation of Latreille.

Head small, but not as broad as thorax, semicircular in shape and closely applied to the thorax; occiput slightly convex above, more or less concave below, eyes usually contiguous for varying distance in the male, wide apart in the female.

Frons much reduced by the contiguous eyes in the male, very broad in the female, the median groove usually distinctly apparent; face generally prominent between the eyes, with dense, short pubescence and with a well marked facial groove. Ocelli distinct, placed on a large, rounded tubercle. Proboscis long, usually rather slender, with small labella; palpi slender and short. Antennae usually longer than head and placed well above the middle of its height; first segment much longer than the second, the third longer than the first and second together, slender, of varying shapes, usually constricted at base, then somewhat attenuated; style usually terminal, and very distinct, and sometimes possessed of a few bristly hairs.

Thorax oval and short, arched, with dense furry pubescence and long intermixed bristly hairs; notopleural bristles usually strong and well developed, though somewhat short; scutellum broad, semicircular in shape, clothed like the thorax, the bristles longer and more conspicuous; squamae not so well developed, with a hairy fringe of varying density; halteres elongate and slender.

Abdomen rounded or oval, short and usually very broad, composed of seven visible segments, and clothed with dense, furry pubescence and long bristly hairs, usually arranged in rows on the posterior borders of the segments.

Legs slender, the hind legs elongate; tibiae with distinct rows of bristles and a circlet of terminal spines or spurs; femora usually with strong spines below, few on the fore femora and numerous on the hind femora; pulvilli distinct; empodium minute.

Wings with well developed lobe and alula; Sc and R_1 contiguous to near the apex of Sc; R_{2+3} usually curved, the curve never large, or the vein recurrent; cell R_5 closed well before the wing margin; r-m placed at or beyond the middle of the cell mc, so that the cell R is always longer than the cell M; cell Cu always open; cells R_3 and R_4 never with interradial veins.

Range.—World-wide.

G. H. Hardy (1921) catalogued eleven species as belonging to the genus, six of which he determined, three being placed as synonyms, the remaining five not being recognized in the material under examination. The material before me is fortunately greater in quantity, and I have been able to separate seventeen distinct species, six of which are regarded as new, and three in too damaged a condition to describe. Of the old descriptions I have been unable to place three, viz., *nanus*, *albicinctus* and *consobrinus*.

The species of *Bombylius* constitute some of the most beautiful of our Diptera with their multicoloured, shining scales, soft, coloured hairs and pictured wings. The adults are flower frequenters and are most plentiful in spring and early summer, though some species are on the wing as late as February and March. Of their life histories nothing is known, though their larval hosts are probably as in other countries, *Hymenoptera*, chiefly bees.

Distribution.—Only one species, *viduus*, appears confined to Tasmania, the other two species known from there, *tenuicornis* and *chrysendetus*, extending to New South Wales and Queensland respectively. The only records of *pulchellus* and *proprius* are from New South Wales, whilst *succandidus*, *bellus*, *dulcis*, *aureolatus* and *pictipennis* occur in Queensland also; *australianus* ranges from Victoria to Queensland; *hilaris* is the only species of which I have any record from Western

Australia, its eastern and northern limit being New South Wales; both *rubriventris* and *tenuirostris* are apparently confined to Queensland.

Key to the Species of Bombylius.

1. Abdomen yellow or reddish with a median, black, denticulated stripe ..... *rubriventris* Bigot
   Abdomen not yellow or reddish 2
2. Wings hyaline and glistening, at most tinged brown at the base and along the fore margin ..... *succandidus*, n. sp.
   Wings subhyaline or smoky with the base and fore margin brown, or hyaline with about one-half their depth brown 3
3. Thorax with whitish or yellowish lateral stripes 4
   Thorax without such stripes 7
4. Abdomen with a central stripe of white scales ..... *aureolatus* Walker
   Abdomen devoid of such a stripe 5
5. Wings subhyaline or smoky, the colour gradually diluting; abdomen without white scales ..... *australianus* Bigot
   Wings divided into definite brown and hyaline halves; abdomen with white scales 6
6. Pleurae and breast of male white haired; abdomen with lateral tufts of black and reddish hairs; the brown of the wings with at least three hyaline spots ..... *pictipennis* Macquart
   Pleurae and breast of male red haired; abdomen without black lateral tufts; the brown of the wings with a single, definite, hyaline spot ..... *hilaris* Walker
7. Abdomen with a central stripe of scales 8
   Abdomen without a central stripe of scales 9
8. Pubescence pale ..... *tenuirostris*, n. sp.
   Pubescence reddish ..... *pulchellus*, n. sp.
9. Abdomen with a basal band of white hairs and some white scales and hairs apically 10
   Abdomen with yellowish or brownish hairs only 11
10. Wings dark brown at base and along fore margin; basal two-thirds of cell Cu coloured ..... *dulcis*, n. sp.
    Wings light brown at base and along fore margin; cell Cu almost clear ..... *bellus*, n. sp.
11. Pubescence bright yellow or golden 12
    Pubescence tawny or brownish 13
12. Wings deep brown at the base and along the fore margin, the brown area distinctly marked off from the remainder of the wing ..... *proprius*, n. sp.
    Wings light brown at the base and along the fore margin, there being no such demarcation of the brown area ..... *chrysendetus* White
13. Face very broad, about the width of two eyes ..... *viduus* Walker
    Face not so broad, about the width of one eye ..... *tenuicornis* Macquart

BOMBYLIUS PROPRIUS, n. sp.

♂. Head mainly dark grey; occiput somewhat darker above, clothed with short, dense, reddish hairs, which become longer, more sparse, and whitish on the chin; eyes contiguous from immediately below the ocellar tubercle for about one-half the length of the frons, their upper facets distinctly enlarged; frontal triangle rather small, with a not very distinct median groove; face clothed with numerous, erect, black bristly hairs and some shorter, golden hairs which are more or less confined to the region of the mouth borders; ocellar tubercle black, with some long, black, bristly hairs. Proboscis black, slender and rather short; palpi small, black. Antennae entirely black, the first segment with long black hairs, the second about one-half the length of the first, with short, sparse, black hairs, the third longer than the first and second together, slightly broadening medianly, thence gradually tapering to the apex; style small, slender.

Thorax black, clothed with dense, short and equal, reddish hairs, with some intermixed red and pale golden bristly hairs, the whole seen from the front with

a golden tint; scutellum black, clothed with reddish hairs and bearing long black and pale yellow bristles; pleurae and breast dark grey; mesopleural tuft reddish with some black hairs intermixed, the hairs of the pleurae and breast much paler; squamae dark, with a short, pale reddish fringe; halteres black knobbed.

Abdomen broad and short, black, as broad as the thorax and about as long as broad, clothed with dense, pale golden or yellowish scales, and on the sides with dense, long, reddish hairs, somewhat paler apically, these reddish hairs being very conspicuous on the basal segment; bristles long and black, with a few intermixed pale golden; venter blackish, clothed with yellow appressed hairs, reddish laterally.

Legs pale yellowish-brown, the coxae dark grey, densely clothed with pale golden scales, the femora with long black hairs below; spines conspicuous on hind femora below, also present on middle femora, but not so apparent.

Wings with base and fore margin to a little past the apex of R_{2+3} and for a little less than half their breadth, blackish, otherwise hyaline; inner margin of the colour rather sharply defined and extending from about the basal third of the axillary lobe to a little beyond the apex of R_{2+3}; r-m placed a little beyond the middle of cell mc.

Holotype ♂, Blackheath, N.S.W., 15th Nov., 1919, G. H. Hardy.

Length of body, 5 mm.; of wing, 6 mm.

The holotype is unique and is in the Queensland Museum.

BOMBYLIUS TENUIROSTRIS, n. sp.

♂. Head mainly grey; occiput clothed above with short, dense, reddish hairs, becoming darker on each side and white on the chin below; eyes contiguous for a short distance, their upper facets enlarged but not much more so; ocellar tubercle black, bearing long black hairs; frontal triangle rather large, clothed with appressed golden scales and some short black hairs; face rather prominent, somewhat narrow, clothed with dense, silver white hairs, and without any black, bristly hairs; mouth opening with very pale borders, rather narrow. Proboscis very long and slender, the labella by no means enlarged; palpi short, black. Antennae somewhat dark greyish, the first segment with long black hairs, the second about half the length of the first, the third rather longer than the first and second together, the basal two-thirds somewhat oval, the apical third slender and linear; style prominent.

Thorax shining black, densely clothed with short, whitish and a few intermixed pale yellow hairs, and appressed golden scales; some short black hairs prominent on each side in front of the wing base and posteriorly; scutellum black, with similar scales and stronger black and some intermixed paler bristles; pleurae and breast dark grey, clothed with dark reddish hairs, the mesopleural tuft pale yellow or somewhat whitish above; squamae pale, with a conspicuous white fringe; halteres with yellowish knobs, much paler at the apices.

Abdomen black, somewhat short, obconical in shape, not very broad, not as broad as thorax and longer than its greatest width; the basal segment is clothed with dense, short, erect, white hairs which extend on each side, otherwise clothed dorsally with black scales; each segment bears a narrow band of golden scales on its posterior border; extending from the second segment to the apex there is a median stripe of similar scales; laterally the second segment bears a tuft of dense black hairs, the remaining segments white hairs, which become less dense apically; the bristles form complete rows on the hind borders of the segments, pale in colour; venter white haired.

Legs mainly black, coxae dark grey and femora pale brownish at face; the femora and tibiae appear covered with black scales, over which some white scales appear to be placed, the latter very conspicuous at the bases of the femora.

Wings subhyaline, the base and fore margin to the apex of Sc, thence directly below through r-m and cells M and R, blackish, the outline of the colour suffused.

Holotype ♂, Dunwich, Q'land, September, 1926, I. M. Mackerras.

Length of body, 6 mm.; of wing, 6·5 mm.

♀. Frons with golden scales and black bristly hairs. Thorax with two short admedian stripes, which extend posteriorly for a short distance only; pleurae and breast white haired, the white hairs extending up on the dorsum to form a small area in front of the wing base.

Allotype ♀, Dunwich, Q'land, September, 1926, I. M. Mackerras.

Length of body, 5·5 mm.; of wing, 6·5 mm.

In the female the scales of the thorax appear to form three distinct stripes, the outer ones being white tomentose anteriorly, thence extending in a curve to the postalar calli, the median stripe being somewhat elongate, triangular in shape, and is widened basally to meet the two outer stripes. In the male the scales appear confined to the median part of the thorax, but the extent and appearance of the scales depend on the condition of the specimen.

The holotype and allotype are in the Macleay Museum.

Bombylius succandidus, n. sp.

♂. Head mainly grey; occiput blackish above, clothed with dense, short, whitish hairs, those behind the vertex, for some distance on either side, stained pale yellowish. Eyes contiguous from immediately below the ocellar tubercle for somewhat less than half the length of the frons, their upper facets distinctly enlarged; frontal triangle with a distinct median groove and clothed with appressed, shining, yellow pile; face rather long and almost perpendicular below antennae, clothed with dense, soft, white hairs which are continued to the chin below to form a short and sparse beard; ocellar tubercle with some long pale yellow hairs; mouth opening rather short with pale yellowish borders. Proboscis black and slender; palpi hidden. Antennae about as long as head, black, the first segment with long dense white hairs, the third longer than the first and second together, linear, slightly curved apically and provided with a distinct and rather elongate style.

Thorax black, clothed with short, dense, very pale yellow or whitish hairs, and appressed shining scales, which have bronze, violet, and greenish reflections, the whole seen from above appearing almost white laterally, and from the front, the hairs of the dorsum seeming to form two short admedian whitish stripes, which in the specimen before me extend for about one-quarter the length of the thorax; pleurae and breast grey, clothed with dense white hairs; mesopleural tuft slightly yellowish above, more so beneath the wing insertions; scutellum black, clothed like the thorax and with numerous very thin, pale bristles; halteres with darkened knobs; squamae dark with a long, pale yellowish fringe.

Abdomen short, not as broad as the thorax and somewhat longer than its own greatest width; the basal segment possesses a band of dense, erect and equal, white hairs which become yellowish beneath the scutellum; the remaining segments are clothed with reflective scales, similar to those of the thorax, the violet reflections predominating; laterally the hairs are long and white, but on the

second segment they are very dense and black; venter mainly white haired, the hairs on the sides of the second and third segments being somewhat yellowish.

Legs mainly black, the fore and middle femora yellowish at base, the hind femora with basal half yellowish, clothed with white scales, the femora with long white hairs below; tarsi with short yellow hairs.

Wings clear hyaline, faintly brown at the base and along the fore margin to the apex of the vein R_1, the colour being dilated from the base to tinge the basal half of cell R_1.

Holotype ♂, Warialda, N. S. Wales, 30th September, 1927, A. P. Dodd.

Length of body, 5 mm.; of wing, 5·2 mm.

Paratypes: 2 ♂, Biniguy, N. S. Wales, 19th January, 1924, F. Roberts; 1 ♂, Chinchilla, Q'land, 3rd October, 1926, B. Smith.

The holotype is in the Queensland Museum.

Bombylius bellus, n. sp.

♂. Head mainly grey; occiput slightly inflated and somewhat darker above, clothed with dense, short, white hairs, which are continued below to form a short sparse beard. Eyes contiguous from below the ocellar tubercle to near the antennal triangle, their upper facets little enlarged; ocellar tubercle with some long black hairs; frontal triangle clothed with golden scales and some short black hairs; face somewhat darker between the upper mouth borders and antennae, clothed with dense, white and numerous black hairs, the former stained yellow immediately below the antennae and the latter more or less encircling the white hairs and extending from beneath the antennae for about half the length of the face; mouth opening not very broad, its borders pale yellow. Proboscis black, rather slender; palpi slender, about one-fourth the length of the proboscis, with some long hairs at the apex. Antennae longer than the head, black, the first segment with some long black hairs, the third longer than the first and second together, with a stout apical style, which bears one or two elongate, sub-apical, bristly hairs.

Thorax black, clothed with appressed golden scales and dense, pale yellow hairs which, viewed from above, appear somewhat whitish on the sides, the whole with numerous pale and black, bristly hairs intermixed; scutellum black, with similar pubescence and numerous pale bristles; pleurae and breast grey, white haired, the mesopleural tuft yellowish above and beneath the wing base; squamae dark, with a short, pale yellow fringe; halteres with pale yellow knobs.

Abdomen black, the basal segment somewhat greyish, rather broad, longer than broad, the first segment with dense, short, erect, white hairs, stained yellow beneath the scutellum, and continued laterally to form clear white basal tufts; the remaining segments are clothed with appressed black scales, with bands of golden scales on their posterior borders; laterally the second and third segments bear alternate tufts of black and yellowish hairs, the latter being contiguous with the transverse bands of golden scales; the fourth segment, a tuft of black hairs anteriorly, white hairs posteriorly, the remaining segments also with white hairs, which become less dense and more appressed apically, and encroach on the dorsum to varying degrees; bristles black and intermixed pale yellowish; venter white haired with long pale bristly hairs.

Legs: coxae black, anterior femora black, yellowish at base, middle and posterior femora yellow, black apically, tibiae brown, the posterior tibiae darker, the whole mainly white scaled, the femora partly golden scaled.

Wings dull hyaline, brown at base and along the fore margin to the apex of the vein Sc, the brown descending to colour the cell M.

Holotype ♂, Gundamain, National Park, N. S. Wales, 14th Feb., 1926, I. M. Mackerras. Length of body, 5 mm.; of wing, 5·5 mm.

♀. Frons broad, clothed with golden scales and black bristly hairs; mesopleural tuft almost pure white, the hairs extending to surround the prealar bristles; body pubescence much lighter than in the male.

Allotype ♀, Woodford, N. S. Wales, 14th November, 1926, I. M. Mackerras. Length of body, 6 mm.; of wing, 7·5 mm.

Paratypes: 2 ♀, G. H. Hardy, Brisbane, September, 1923; January, 1927; 1 ♂, 2 ♀, F. Roberts, Brisbane, 9th September, 1927; 1 ♀, J. Mann, Brisbane, 17th September, 1927; 1 ♂, A. J. Nicholson, Como, 2nd December, 1923.

The species varies somewhat in the colour of the legs. The fore femora are usually black with the bases yellow or reddish, but the colour may vary to yellow with the apices black; the middle femora are usually yellow with the apices black, but they sometimes possess a dark reddish tinge above.

The holotype and allotype are in the Macleay Museum.

BOMBYLIUS DULCIS, n. sp.

♂. Head mainly grey; occiput slightly convex, clothed with short, equal, and dense white hairs, continued below to form a thin white beard. Eyes contiguous for about half the length of the frons, their upper facets enlarged. Frontal triangle rather broad, bearing short, inconspicuous black hairs and some appressed golden scales; face rather prominent, clothed with dense, long, black, bristly hairs, with which are intermixed some short, whitish, or pale yellowish hairs, and some pale, golden scales; mouth opening not very long and rather narrow with pale borders; ocellar tubercle black, with some long, erect, black hairs. Proboscis about three times the length of the mouth opening, slender, palpi slender, about one-fourth the length of the proboscis, with some sparse hairs. Antennae dark greyish, not as long as the head, the first segment with some long black hairs, the second not quite half the length of the first, the third longer than the first and second together, slightly broadening for the basal third, thence gradually tapering to the apex; style distinct and rather elongate, about one-eighth the length of the third segment, with one or two short, subapical bristly hairs.

Thorax deep black, clothed with short, dense and equal pale, dull brown hairs and appressed golden scales, and with numerous black hairs intermixed, especially posteriorly and laterally; postalar bristles extremely weak, black, and rather short; scutellum black, similarly clothed, but with longer and more conspicuous bristles, much paler in colour; pleurae and breast dark grey, clothed with somewhat golden hairs, the mesopleural tuft more reddish, with some intermixed black hairs; squamae blackish with a short white fringe; halteres with yellow knobs.

Abdomen very broad and short, not as long as broad, and about as broad as the thorax; first segment with numerous erect white hairs, which extend laterally, and are yellowish beneath the scutellum; these hairs appear continued over the anterior border of the second segment, but are longer and more appressed, very thin and stained yellowish medianly; remaining segments with black scales, their posterior borders with bands of golden scales, not so conspicuous apically; laterally the second and third segments bear dense, long, black hairs, pale golden where in contact with the golden dorsal bands; fourth segment with black hairs on its anterior border only, from thence to the apex the

hairs being white, encroaching to some extent on the dorsum, especially on the sides of the fourth and fifth segments; bristles in complete rows, black; venter pale haired, with some golden and white scales and white hairs, and long intermixed pale golden and black hairs laterally.

Legs: coxae, apices of femora, and apical tarsi, blackish; otherwise brownish, clothed with golden scales, the femora beneath and at base white haired, femora also appear to possess some white scales above; middle femora with about four, and hind femora with about twelve spines beneath.

Wings dull hyaline, the base and fore margin to a little past the apex of R_1, deep brown, the colour descending to colour all cell M, half Cu, thence across to near the apex of R_1, its inner margin somewhat suffused.

Holotype ♂, Westwood, Q'land, October, 1926, A. P. Dodd. Length of body, 6·5 mm.; of wing, 9 mm.

♀. Upper half of frons dark, with golden scales and erect black bristly hairs; face with white hairs only; hairs of thorax appear shorter, less dense, and paler, whilst the scales appear denser and brighter; pleurae and breast white haired, the mesopleural tuft yellowish beneath the wing insertion, the white hairs extending on to the dorsum and forming a small white area anterior to the wing base; venter and legs appear mainly white scaled.

Allotype ♀. As holotype. Length of body, 7 mm.; of wing, 10 mm.

Paratypes, 1 ♂, 3 ♀, Westwood, October, A. P. Dodd; 3 ♂, 1 ♀, Eidsvold, Q'land, I. M. Mackerras. Specimens also from Goondiwindi, Q'land (November) and Gravesend, N. S. Wales (December to February).

The holotype and allotype are in the Queensland Museum.

Bombylius pulchellus, n. sp.

♂. Head mainly grey; occiput darker above, clothed with dense, short, reddish hairs, which become much paler and more sparse on the chin. Eyes not contiguous at any point, their upper facets enlarged. Frons very narrow between the closely approximated eyes, at its narowest point about equal in width to the fore ocellus; frontal triangle rather large, with a distinct median groove and some black hairs on each side and towards the antennae; face clothed with dense white hairs, stained yellowish beneath the antennae and with numerous, encircling, black, bristly hairs; mouth opening rather narrow, with pale yellow borders. Proboscis slender, black; palpi very short, black. Ocellar tubercle black, with some long black hairs. Antennae entirely black, longer than the head, the first segment with some long black hairs, the second about one-third the length of the first, the third about as long as the first and second together, the basal half somewhat oval, the apical half slender and linear; apical style distinct.

Thorax black, clothed with dense, short and equal, dull reddish hairs which, seen from the side, have a yellowish sheen; prealar bristles reddish, postalars thin, pale; pleurae and breast greyish, clothed with brownish red hairs, the mesopleural tuft darker above, but paler beneath the wing insertions; squamae dark, with a long pale fringe; halteres with blackish knobs; scutellum black, with pale golden hairs and long, pale reddish bristles.

Abdomen black, rounded, rather broad, but longer than broad, with numerous black scales; first segment with erect short, pale yellowish or whitish hairs, second, third and fourth segments with narrow bands of reddish scales on their posterior borders, and some white scales medianly, which are more or less coalescent and form a distinct, median, longitudinal stripe, much dilated apically, so that the

apical segments appear clothed with white scales with reddish scales laterally, the white scales on the second and third segments interrupted by reddish scales; laterally the hairs are black, with intermixed long, pale brownish hairs, the hairs forming long, dense tufts on the sides of the second, third and fourth segments, the black hairs being contiguous with the black scales of the dorsum, and the brownish hairs with the narrow red scaly bands; bristles rather strong, pale brownish or reddish; venter clothed with appressed and erect brownish tomentum and bristly hairs.

Legs mainly blackish, the femora with brownish tints, clothed with dull golden scales, the femora with long black hairs beneath; spines beneath middle and hind femora pale brown.

Wings deep brown at the base and along the fore margin to the apex of cell R_1, and for about half the breadth; the inner margin of colour is very irregular, more or less straight from the base to the cell mc, then with three conspicuous indentations and two dilatations, the first extending for about two-thirds the distance of that portion of vein M_1 between mc and R_1 and the second one to the junction of R_4 and R_5.

Holotype ♂, Woodford, N. S. Wales, 14th November, 1925, A. J. Nicholson. Length of body, 6 mm.; of wing, 5·5 mm.

Paratype ♂, Como, N. S. Wales, 8th October, 1921, G. H. Hardy.

The holotype is in the Macleay Museum.

Bombylius tenuicornis Macquart.

Bombylius tenuicornis, Macquart, *Dipt. Exot.*, suppl. 1, 1846, 116; White, *Proc. Roy. Soc. Tasm.*, 1916, 192; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 73 and 1923, 86.—*Bombylius matutinus*, Walker, *List Dipt. Brit. Mus.*, ii, 1849, 281; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 73.—*Bombylius fuscanus*, Macquart, *Dipt. Exot.*, suppl. 4, 1850, 119; White, *Proc. Roy. Soc. Tasm.*, 1916, 193; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 72; 1923, 86.

♂. Head mainly grey; face and frons brownish; occiput little convex, covered with short, dense and equal brownish hairs, which become paler below to the sparse whitish beard, and with numerous bristly black hairs intermingled. Eyes contiguous for a very short distance below the ocellar tubercle, their upper and inner facets distinctly enlarged; frontal triangle rather large, with a well marked median groove, clothed with depressed, pale scales and some short black hairs; face much projecting between the eyes, rather narrow and almost parallel-sided, brownish but running to grey-black on the chin, clothed with short, pale golden and longer, black bristly hairs. Proboscis black, long and slender; palpi short, black, with some long hairs at their apices. Antennae entirely black, the first segment with long black hairs, the third about one and one-half times the length of the first and second together, broadening medianly to a rather blunt apex and provided with a distinct and somewhat stout style.

Thorax black-brown, clothed with dense, short and equal, brown or tawny hairs, seen from above somewhat paler laterally; the hairs near the scutellum appear pale golden in certain lights, the whole seen from the front with a very pale yellowish or whitish sheen; prealar bristles stout and brown, postalars thin and black; scutellum with similar pubescence and long, thin, black, marginal bristles; pleurae dark grey, clothed with brown and a few intermixed pale hairs; halteres with golden yellow knobs; squamae brown with a short pale fringe.

Abdomen broad and short, rather rounded, clothed with depressed pale golden scales and long, brown or tawny hairs; bristles long, thin and black; venter with intermixed depressed pale brown and erect, black, bristly hairs; the hairs on the abdomen are longest and densest on the sides and viewed from above appear somewhat paler.

Legs mainly brown, coxae and tarsi darker, clothed with brown scales, the femora with long, black hairs beneath.

Wings subhyaline or smoky, dark brownish at the base and along the fore margin for two-thirds the length, the colour descending to darken cell M, thence diluting to the apex and inner margin, leaving about half the breadth and the apex subhyaline.

The female is similar with a much wider frons.

Length of body, 5-9 mm.; of wing, 6-9·5 mm.

Hab.—New South Wales: Woodford (September), National Park (November), Como (October), Garden Is. (December); Tasmania: Hobart (November).

It is possible that *consobrinus* is also synonymous with *tenuicornis*, being described from both Australia and Tasmania. Macquart's description is very inferior and short, and it may have been taken from a small specimen of *tenuicornis* or a large specimen of *chrysendetus*.

The species I have determined as *tenuicornis* is Hardy's *fuscanus*, the name *tenuicornis* being used by him for those species he considered allied to *fuscanus*. At that time, however, he was not aware that certain species of *Bombylius* occurred both on the mainland and in Tasmania.

White compares *viduus*, his *palliolatus*, with this species, and remarks that *viduus* is a much more hairy insect, for, whilst *tenuicornis*, even in fresh specimens, has a bare and denuded look, *viduus* is completely covered with a thick and long furry pubescence. The chief distinction is to be found in the width of the face, that of *viduus* being almost twice the width of that of *tenuicornis*, in comparison with the width of the eyes of the two species.

Bombylius aureolatus Walker.

Bombylius aureolatus, Walker *Trans. Ent. Soc. Lond.*, iv, 1857, 145; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 73; 1923, 86.

♂. Head mainly grey; occiput little convex, dark brown above, this area being clothed with reddish hairs, below which on each side is a patch of softer, whitish hairs, separated from the whitish beard below by some brownish hairs. Eyes contiguous for some distance below the ocellar tubercle, their upper facets distinctly enlarged; ocellar tubercle black, with some long, erect, black hairs; frontal triangle with some appressed golden scales; face not very prominent, rather narrow, with long black hairs, which are also present on the chin in front of the beard. Antennae entirely black, the first segment with long black hairs, the third longer than the first and second together, of a somewhat elongate oval shape, with a distinct apical style. Proboscis long and slender, black; palpi short, black.

Thorax deep brown, greyish laterally, clothed on the brown area with golden scales and dense, short, reddish brown hairs, and on the greyish area with whitish scales and dense hairs of a similar colour, which extend for the full length and meet the white, lateral patches of the occiput, in front; prealar bristles stout, reddish, postalars long, black; scutellum reddish, black basally, clothed with golden scales and margined with dense white hairs, which meet the white lateral

stripes of the thorax, the thorax and scutellum therefore appearing enclosed, except anteriorly, by a white stripe; pleurae and breast grey, reddish haired, paler below; squamae dark brown with a short golden fringe; halteres with yellow knobs.

Abdomen black, broad, but longer than its greatest width, with reddish-golden scales and long black bristles; the first segment is clothed with short, dense, erect, reddish hairs, which are of a greater length and more sparse on the remaining segments; extending from the second segment to the apex is a median dorsal stripe composed of almost contiguous spots of white scales; laterally, the first segment bears short, dense reddish hairs, the remaining segments some longer reddish and intermixed white hairs, the red hairs disappearing towards the fourth segment, and the white hairs becoming more conspicuous, so that the apical segments are mainly clothed laterally with white hairs; the venter is clothed with reddish hairs, very long and dense on the sides.

Legs: coxae grey, femora somewhat reddish or dark yellowish, tibiae darker at apex, tarsi black; the femora are mainly clothed with reddish scales, but with traces of black scales above, and long black hairs below.

Wings subhyaline, with base and fore margin to the apex of cell R_1 deep brown, the colour including half cell Cu, all cell M, thence across to the apex of R_{2+3}, including r-m.

♀. Eyes almost parallel; frons with reddish-golden scales, and long, black, bristly hairs; pleurae and breast white haired; mesopleural tuft reddish above, so that white hairs of the pleurae and the white lateral stripe of the thorax above, appear separated by a red stripe; abdomen apparently predominantly white haired laterally; femora and coxae white haired.

Length of body, 5-10 mm.; of wing, 5·5-10 mm.

Hab.—Dunwich, Q'land (September); Sydney, N. S. Wales (October).

Bombylius viduus Walker.

Bombylius viduus, Walker, *Ins. Saund. Dipt.*, 1850, 199; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 73.—*Bombylius palliolatus*, White, *Proc. Roy. Soc. Tasm.*, 1916, 194; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 73; 1923, 86.

♀. Occiput moderately convex, clothed with dense, light fuscous hairs, which become paler below to form an almost white beard. Eyes broadly separated, about the width of one eye at the vertex, their upper and lower facets of an almost equal size. Frons much broadened to antennae, blackish, clothed with appressed golden scales and long, black, bristly hairs; face brownish, rather prominent, very broad, about equal to the width of both eyes together, clothed with short golden and long black, bristly hairs; mouth opening somewhat narrow with pale borders. Antennae entirely black, the first segment with long black hairs, the third elongate and slender; style apical and distinct, with one or two minute subapical bristly hairs.

Thorax dark brownish, clothed with dense, erect, brownish hairs, paler on the sides; pre- and post-alar bristles black; scutellum brownish, clothed with similar hairs, the bristles long and black; pleurae and breast pale haired, the mesopleural tuft brownish above; squamae brown, with a thin pale yellowish fringe; halteres with brownish knobs.

Abdomen broad and short, hardly longer than broad, clothed with long brownish hairs, densest laterally, and bearing long black bristles; venter pale haired at base, otherwise with brownish scales and long black bristles.

Legs: coxae and basal halves of anterior and middle femora blackish, most of posterior femora black, remainder of femora, and most of tibiae brownish; the femora appear clothed with brown scales with a few whitish scales and long hairs below, the tibiae with white scales which, against the ground colour, appear at times brownish.

Wings brownish at base and along the fore margin, the colour gradually becoming paler, leaving the wing, except for the apex and hind margin, smoky.

Length of body, 7 mm.; of wing, 7·5 mm.

Hab.—Tasmania: Hobart (October).

The description is taken from two rather badly damaged females in the collection of Mr. G. H. Hardy. White described the male only (*Proc. Roy. Soc. Tas.*, 1916) and, except for the contiguous eyes, it apparently differs in no wise from the female. The species is very similar to *tenuicornis*, but the pubescence is much lighter in colour and the face is very much broader.

Bombylius pictipennis Macquart.

Bombylius pictipennis, Macquart, *Dipt. Exot.*, suppl. 4, 1850, 118; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 74.

♂. Head mainly greyish; occiput dark brown above, clothed with short, dense, reddish hairs, followed by a silver grey area clothed with white hairs, below which the hairs become somewhat brownish to the white beard below. Eyes contiguous, their upper facets larger; frontal triangle prominent with a distinct median groove, clothed with reddish scales on each side and above, and black scales medianly and below; face prominent between the eyes, with long intermixed reddish brown and black bristly hairs, the latter more or less encircling the former which appear confined to an area near the mouth borders; ocellar tubercle large, with long black hairs. Proboscis black, slender; palpi very small. Antennae longer than the head, the first segment with numerous black and intermixed red hairs, the third about one and one-half times the length of the first two segments together, broadening medianly and with a rather blunt apex which is provided with a slender minute style.

Thorax black, greyish laterally, clothed with short, dense, equal, reddish and a few intermixed black hairs and appressed reddish scales; laterally there is a stripe of dense greyish hairs which extend from the postalar calli, above the wing insertions, to the white areas of the occiput; prealar bristles strong, reddish, postalars thin, black; scutellum black with reddish scales and hairs and long, thin, black, marginal bristles; pleurae grey, clothed with white hairs; mesopleural tuft reddish above, the red hairs appearing as a stripe separating the white hairs of the pleurae from the whitish lateral stripes of the thorax; squamae pale with a long, dense fringe of white hairs; halteres with knobs somewhat brownish.

Abdomen short and broad, about as long as its greatest width; across the basal segment and the anterior border of the second extends a band of white hairs, those on the first segment being erect and equal, those on the second short and appressed; the dorsal tomentum otherwise consists of appressed reddish scales and numerous intermixed reddish and black bristly hairs; extending from the third segment to the apex are many white appressed and erect hairs, which become denser towards the apex, so that the apical segments are covered mainly with white hairs, which in an undamaged specimen form bands, the hairs being longest and densest laterally; on the sides of the second, third, fourth and fifth segments

are numerous long, black and intermixed reddish hairs, forming tufts; venter with white appressed hairs medianly and small areas of white scales laterally.

Legs reddish-brown, with the coxae greyish, clothed with reddish scales, the femora white scaled at the base and with long black hairs beneath.

Wings dark brown at the base and along the fore margin for almost their total length and about one-half their breadth, the rest of the wing being hyaline; the brown area usually contains three hyaline spots, the first two being small and placed in the median basal cell and near the origin of R_4, the third, rather large and contained in cell R_1; the inner border of this coloured area is very irregular and is composed of three distinct curves, the basal and largest one descending to colour one-third of cell M_4, the second, the basal third of cell mc, and the third, which is rounded, the apical portion of mc; at the extreme apex of the brown area, a fourth hyaline spot is sometimes apparent.

The female is similar, the eyes being wide apart; the frons is clothed with golden scales, with long black hairs above.

Length of body, 8-10 mm.; of wing, 10-12·5 mm.

Hab.—Q'land: Brisbane (August-September); N. S. Wales: Sydney (July-September).

This beautiful species is apparently the first Bombyliid on the wing, two specimens in the collection of Mr. A. J. Nicholson being taken at Lindfield in July. Around Brisbane its earliest record is August, when it is rather plentiful.

Bombylius hilaris Walker.

Bombylius hilaris, Walker, *List Dipt. Brit. Mus.*, ii, 1849, 274; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 73; 1923, 85.

♂. Head mainly grey; occiput as in *pictipennis*; ocellar tubercle with some long black hairs. Eyes contiguous; frontal triangle small, clothed with appressed reddish scales; face prominent between the eyes, clothed with dense reddish and numerous, black, bristly hairs, the latter more or less encircling the former; beard thin, white. Proboscis black, slender; palpi small, slender, with some longer apical hairs. Antennae entirely black, the first segment with some long black and intermixed reddish hairs, the third longer than the first and second segments together, slender, and provided with a stout style somewhat subapical in position.

Thorax similar to that of *pictipennis*, though the pleurae and breast are red haired; halteres with darkened knobs; squamae dark, with a yellowish fringe.

Abdomen short and broad, and hardly as long as broad, black, the basal segment rather greyish; there is a basal white band as in *pictipennis*, the red scales being also present; the second segment possesses long red hairs laterally, these hairs becoming shorter and intermingled with white hairs towards the apex; from the third segment to the apex, white scales are apparent, forming thin white bands, more conspicuous on the apical segments; the bristles are long, thin and black; the venter is clothed with red scales, black towards the apex.

Legs brown to brownish-red with grey coxae, clothed with somewhat golden scales, the femora with long black hairs below; pulvilli pale.

Wings divided into an upper dark brown half and a lower hyaline half, the dividing line being irregular and consisting of three waves, the apices of which are practically of an equal depth in the wing; there is a single hyaline spot near the apex of cell R_1.

♀. Frons very broad, clothed with red scales and long black bristly hairs; pleurae and breast white haired; mesopleural tuft reddish above.

Length of body, 7-9 mm.; of wing, 8·5-10 mm.

Hab.—N. S. Wales: Armidale, Darlington (September); W. Australia: Mundaring.

At first glance this species is very similar to *pictipennis*, but in the latter species the hairs of the face are more brownish than red, the pleurae in the male are mainly white haired, the abdomen bears tufts of long black and reddish hairs laterally, the venter has white scales on the sides, and in the wings the inner border of the brown is much more irregular, the apices of the waves in *hilaris* being almost on the same level, and the hyaline spots of *pictipennis* being at most replaced by lighter areas.

Bombylius australianus Bigot.

Bombylius australianus, Bigot, *Ann. Soc. ent. France*, (7), lxi, 1892, 364; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 73; 1923, 86.

♂. Head mainly grey, the frons somewhat darker; occiput little convex, clothed with dense, short, equal, reddish hairs, which become paler below to the very pale golden, almost whitish beard. Eyes contiguous from immediately below the ocellar tubercle to near the antennal triangle; frontal triangle small with appressed golden scales; face prominent between the eyes, clothed with golden scales and hairs and numerous, erect, black, bristly hairs; mouth borders pale brownish with a short sparse golden moustache; facial groove deep and well marked. Proboscis black, long and slender, with enlarged labella; palpi small, about one-third the length of the proboscis. Antennae entirely black, the first segment with long black hairs, the third elongate, about one and one-half times the length of the first and second together, and provided with a distinct and rather stout style.

Thorax black, greyish laterally, clothed with appressed, golden scales, and dense, short and equal reddish hairs, with a stripe of whitish or very pale yellowish hairs on each side, which extends from the postalar callus to the collar; prealar bristles strong, short and brownish, postalars long, thin and black; scutellum reddish, black basally, clothed with golden scales and bearing long, black bristles; pleurae grey, with somewhat golden hairs, the mesopleural tuft reddish above, so that the golden hairs of the pleurae appear separated from the whitish lateral stripe of the thorax by a line of reddish hairs; halteres with yellow knobs; squamae pale with a pale golden fringe.

Abdomen black, somewhat rounded, but rather longer than its greatest width, the basal segment with a distinct but narrow band of erect reddish hairs, the remaining segments with dense golden scales and scattered golden hairs, densest on the sides, and lighter in colour than the hairs on the first segment; bristles black; venter with pale golden tomentum and bristles.

Legs mainly pale reddish with grey coxae and darker tarsi, clothed with reddish scales, the femora with long, black hairs below, the scales in certain lights appearing whitish, and the fore and middle femora sometimes black basally.

Wings subhyaline, brownish at the base and along the fore margin to the apex of cell Sc, the colour including the basal portion of cell Cu, the basal two-thirds of cell M, and about one-half of cell R_1.

♀. Frons very broad, clothed with golden scales and erect black, bristly hairs; pleurae, breast, and venter white haired, the mesopleural tuft with reddish and intermixed black hairs above; legs somewhat paler, the white scales more apparent, and the femora white haired at the base and beneath.

Length of body, 7-12 mm.; of wing, 7·5-10 mm.

Hab.—Queensland: Brisbane (August-January); N. S. Wales: Sydney (September-January), Kosciusko (February), Woodford (November); Victoria: Gisborne (December).

Hardy (*Proc. Roy. Soc. Tasm.*, 1924) makes *tenuicornis* synonymous with *australianus*. The former species, however, was described with both Australia and Tasmania as localities, and as far as is known the species identified by me as *australianus* is confined to the mainland.

BOMBYLIUS CHRYSENDETUS White.

Bombylius chrysendetus, White, *Proc. Roy. Soc. Tasm.*, 1916, 195; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 74; 1923, 86.

♂. Head mainly greyish, the mouth borders pale yellowish; occiput little convex, clothed with appressed golden scales and dense, short and equal yellow hairs which become much paler to the thin sparse beard below. Eyes contiguous from beneath the ocellar tubercle to near the antennal triangle, the upper facets distinctly larger, their demarcation from the smaller, lower facets very evident; frontal triangle small, the median groove well marked, clothed with appressed golden scales; face with numerous black, bristly hairs and a thin but long, yellowish moustache; facial groove well marked. Proboscis black and slender; palpi short and thin, with long hairs at the apex; ocellar tubercle black, with some long black hairs. Antennae entirely black, the first segment with long black hairs, the second about two-thirds the length of the first, the third longer than the first two together, the basal two-thirds somewhat oval, the apical third linear, with a small but distinct apical style.

Thorax black, clothed with short, dense and equal yellow hairs and appressed golden scales; prealar bristles stout and pale, postalars long, thin and black; scutellum black, clothed with appressed golden scales and yellow hairs and bearing long, black bristles; pleurae grey, with yellow hairs, somewhat paler on the breast; squamae yellow, with a thin paler fringe; halteres with yellow knobs.

Abdomen somewhat oval, longer than broad, clothed with shining golden scales and erect yellow hairs, the former predominating and the latter rather sparse, but densest laterally, and forming a distinct band on the first segment; bristles mainly black; venter grey, clothed with paler appressed tomentum and erect bristly hairs.

Legs with the coxae grey, the femora yellow, black at the apices, the hind femora more so, the anterior and middle tibiae yellow, the posterior tibiae brown, tarsi dark; the femora are clothed with golden scales, somewhat whitish beneath, and with long pale hairs; hind femora with 6-8 long spines below.

Wings hyaline, with base and fore margin brown; the veins C and Sc appear contiguous except at the extreme apices, the colour appearing darker at this spot; apical cross-vein of mc much reduced.

♀. Frons very broad, clothed with appressed golden scales and some erect, black, bristly hairs; face mainly covered with pale golden or yellowish hairs.

Length of body, 3·5-6 mm.; of wing, 4-6·5 mm.

Hab.—Queensland: Brisbane (October), Chinchilla (October), Eidsvold (October); Tasmania: George Town (December).

White compares this species with Walker's *Bombylius nanus*, and says, "This species bears a considerable resemblance to *B. nanus* Walk. from Western Australia. It is probably distinct, but the type being in bad condition, the question cannot be

satisfactorily settled until more specimens from Western Australia are available for comparison".

This species varies somewhat in the colour of the legs. The series examined consisted of 12 ♂ and 9 ♀, 16 of which were from George Town, Tasmania. The femora are usually yellow, black apically, but in 3 ♂ from Tasmania they are dull reddish, and in two others the posterior femora are almost wholly black. The tibiae may be yellowish, sometimes black apically, and sometimes reddish, black apically.

BOMBYLIUS RUBRIVENTRIS Bigot.

Bombylius rubriventris, Bigot, *Ann. Soc. ent. France*, (7), lxi, 1892, 365; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 74.

♂. Head mainly grey; occiput clothed with dense, short and equal yellow hairs, which become paler to the almost whitish beard below; eyes contiguous for about one-third the length of the frons; frontal triangle small, covered with appressed, yellow scales and some black hairs; face projecting between the eyes, covered with dense, erect, yellow hairs, somewhat paler on the cheeks; ocellar tubercle black, with some long, black hairs. Proboscis very long and slender, black; palpi small, black; mouth opening very broad. Antennae mainly black, as long as the head, the first segment with some long black hairs, the third longer than the first and second together, with a distinct, slender, apical style.

Thorax blackish, covered with dense, short and equal yellow hairs, with some black hairs intermixed; bristles weak, yellowish; scutellum black, with similar yellow hairs, the bristles long, thin, and mainly black; pleurae and breast grey, clothed with pale yellow hairs, the mesopleural tuft darker above; squamae pale brown with a short yellow fringe; halteres yellow.

Abdomen broad and rounded, the first segment black, the remainder yellow, with a median black, dorsal stripe, the stripe being denticulated at the anterior and posterior borders of each segment, the whole clothed with yellow hairs, densest laterally; bristles forming complete rows on the posterior borders of each segment, black, longest apically; venter dark grey, the posterior borders of the segments almost a pale brown, yellow pollinose.

Legs mainly yellowish, posterior tibiae and apices of posterior femora, and tarsi dark brown, clothed with yellow scales, the femora with pale hairs beneath.

Wings clear hyaline, light fuscous at the base and along the fore margin to the apex of cell Sc.

The only female I have seen is of a much smaller size, with a broad frons, clothed with shining yellow scales and black hairs. The abdomen is more reddish than yellow, but this is possibly due to the condition of the specimen.

Length of body, 6-10 mm.; of wing, 5·5-9 mm.

Hab.—Queensland: Westwood (November), Pt. Denison.

The identification of *rubriventris* has puzzled me for quite a while. There are three or perhaps four species which agree in many points with Bigot's description. Bigot, however, mentions the wings as being hyaline, and the species described above is the only one in which this is the case. In the others the wings are smoky or subhyaline, brown at the base and along the fore margin for some depth. Unfortunately these species are only represented by one or two specimens in a rather badly damaged condition. A short description of each of these would not, I think, be amiss.

1. A large black species from the Atherton Tableland, North Queensland, clothed with golden yellow hairs and possessing a red scutellum, a deep red abdomen with a narrow, almost parallel-sided, median black stripe. The wings are subhyaline, dark fuscous at the base and along the fore margin, the colour descending to cell M, its outline suffused.

2. A medium-sized species from Stanthorpe, Queensland, with a black scutellum, a red abdomen with a broader, black, denticulated stripe, and clothed with yellowish hairs. The wings are smoky, the base and fore margin dark brown, the colour more defined and deeper than in the previous species.

3. A dark brownish species from Galston (New South Wales) and Brisbane (Q'land), clothed with a pale brownish pubescence. The abdomen is tinged red, with an extremely broad black, denticulated stripe, the apical segments appearing all black. The wings are similar to those of the preceding species.

Species not Recognized.

BOMBYLIUS CONSOBRINUS *Macquart.*

Bombylius consobrinus, Macquart, *Dipt. Exot.*, suppl. 2, 1847, 54; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 75.

"Flavo hirtus. Pedibus rufis. Alis fuscanis, basi limboque externoque fuscis.

"Long. 2 l. ♀, ♂, ♀. Trompe longue d'une ligne un tiers. Face et front d'un fauve grisâtre. Antennes: les deux premiers segments noirs. Thorax et abdomen en grande partie dénudés. Tarses bruns. Ailes: première cellule postérieure fermée, à nervure terminale aboutissante au milieu de la partie de la sous-marginale au-delà de l'angle; petite transversale située au milieu de la discoïdale.

"De la Nouvelle-Hollande et de la Tasmanie".

BOMBYLIUS ALBICINCTUS Macquart.

Bombylius albicinctus, Macquart, *Dipt. Exot.*, suppl. 2, 1847, 54; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 74.

"Rufo hirtus. Abdomine albo fascialio. Pedibus nigris, tibiis rufis. Alis hyalinis limbo externo fusco.

"Long. 3 l. ♀. Face d'un jaune blanchâtre. Front à duvet fauve et poils noirs. Antennes noirs. Thorax et abdomen à fourrure fauve; quatrième segment de ce dernier à longs poils blancs au bord antérieur. Ailes: première cellule postérieure fermée, à nervure terminale aboutissante aux deux tiers de la partie de la sous-marginale, au-delà de l'angle; petite transversale située au milieu de la discoïdale.

"De la Tasmanie".

BOMBYLIUS NANUS Walker.

Bombylius nanus, Walker, *List Dipt. Brit. Mus.*, 1849, 278; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 74.

"Niger, pilis fulvis rufisque vestitus, pectore albo piloso, abdomine pilis flavis rufisque vestito subtus cano, antennis nigris, apice piceis, femoribus flavis, tibiis ferrugineis, tarsis piceis, alis subcinereis, basi et ad costam fuscis.

"Body black, thickly clothed with bright tawny and red hairs; a tuft of black bristles on the crown of the head, whose front is thickly clothed with shining yellow hairs; feelers nearly as long as the head; first and second joints black, and thickly beset with black bristles; 2nd joint much shorter than the first; 3rd joint piceous, spindle shaped, nearly as long as the first and second; fourth joint very small, with

two or three bristles at the tip; mouth black, shorter than the chest; eyes piceous; breast clothed with white hairs; abdomen with alternate bands of bright yellow and red hairs; underside hoary; legs slightly clothed with bristles and hairs; thighs yellow, with a ferruginous stripe from the base to the tip, which like the shanks is also ferruginous; feet piceous; wings slightly grey, brown at the base and along the fore border till near the tips; the brown colour occupies rather less than half the surface of the wing; wing ribs and veins piceous, the latter black towards the tips; poisers tawny.

"Length of the body, 2½ l.; of the wings, 6½ l.

"West Australia".

Genus Dischistus Loew.

Dischistus, Loew, *Neue Beitr.*, iii, 1855, 45; White, *Proc. Roy. Soc. Tasm.*, 1916, 192; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 68; 1923, 82.

Genotype, *Bombylius minimus* Schnk, by Brunetti's designation (1910).

In general characters similar to *Bombylius*, but the cell R_5 is open.

Range.—Europe, Asia, Africa, South America, Australia.

At the present time the limits of this genus appear ill-defined. Bezzi has placed a large number of species from South Africa in the genus, the relative length of the cells R and M being apparently the only constant character. These species vary in the proximity of the antennae, the width of the frons at the vertex in the male, the bareness of the metapleurae, and the development of the alulae. The same divergence of characters is to be found among the Australian species, though not so noticeably. Three species are placed in the genus, all of which are regarded as new. They all agree in having approximate antennae, contiguous eyes, and wings with cell R longer than cell M. Both *formosus* and *pallidoventer* have a very short, stout, proboscis, an elongate abdomen, somewhat conical in shape, and narrow, slender wings, with the alulae much reduced, whilst in *perparvus*, the proboscis is very long and slender, the abdomen short and broad, and the wings stout. It is more than likely that these three species belong to two distinct genera, but at the present time their separation is not convenient.

Distribution.—No records of the genus are known from South Australia or Western Australia. The most widely distributed species appears to be *pallidoventer*, which is known from Tasmania, Victoria, and New South Wales. Queensland possesses the other two species *formosus* and *perparvus*, both of which no doubt have a wider southern and western range.

Key to the Species of Dischistus.

1. A small species with a short and broad abdomen; wings stout .... *perparvus*, n. sp.
   Medium-sized to large species, with a conical abdomen, and long narrow wings ... 2
2. Wings with the costal third for its full length, fuscous ..... *pallidoventer*, n. sp.
   Wings at most brownish at the base and for a short distance along the fore margin ..... *formosus*, n. sp.

Dischistus formosus, n. sp.

♂. Head mainly grey; occiput somewhat flattened above, slightly convex below, clothed with dense, bright yellow hairs, which become much paler below to the beard. Eyes contiguous from immediately beneath the ocellar tubercle to near the antennal triangle, which is small and clothed with appressed golden scales; face, prominent between the eyes, clothed with dense black hairs, and with a bright, yellow moustache; cheeks much reduced. Proboscis very short and stout, with

much enlarged labella; palpi slender, about one-third the length of the proboscis. Antennae as long as the head, the first segment rather short, with dense, black hairs, the second about two-thirds the length of the first, with short black hairs, the third much longer than the first and second together, somewhat linear and stout, and provided with a small slender style placed on the inner edge of the broad apex.

Thorax jet-black, clothed with appressed, golden scales, and dense, erect, short and equal, darker yellow and a few intermixed black hairs; notopleural bristles stout and black; scutellum black, with golden pile and long, thin, black bristles; pleurae and breast grey, pale yellow haired; halteres slender, with reddish knobs; squamae brownish, with a long and dense yellow fringe.

Abdomen black, somewhat conical in shape, about as long as the thorax, covered with appressed, golden scales and pale golden or bright yellow hairs, densest laterally, and with rows of long, thin, black bristles or bristly hairs; genitalia brownish; venter grey, covered with appressed very pale yellow hairs, with some pale, bristly hairs intermixed.

Legs mainly brown, the coxae greyish and the apical tarsi darker, the femora with pale golden scales and long yellowish hairs beneath, the tibiae with appressed black hairs; spines black; spines on fore tibiae very short and weak; pulvilli pale.

Wings slender and rather narrow, pale smoky, almost hyaline, yellowish at the base and along the fore margin for about two-thirds the length; cell Sc much reduced; alula much reduced; R_{2+3} little curved at apex; r-m placed well beyond the middle of the discal cell, the cell at this point being rather broad; cell M_3 almost square in shape.

Length of body, 10 mm.; of wing, 9·8 mm.

Holotype ♂, Brisbane, Queensland, 3rd September, 1927, J. Mann.

The female has a much broader frons clothed with golden scales and erect black hairs, but is otherwise similar to the male.

Length of body, 11 mm.; of wing, 10 mm.

Allotype ♀, Brisbane, Queensland, 9th September, 1927, F. Roberts.

Paratypes: 8 ♂, 5 ♀, Brisbane, September, 1927, J. Mann; 1 ♂, 1 ♀, Brisbane, August, G. H. Hardy; 1 ♂, 2 ♀, Brisbane, September, F. Roberts; 2 ♂, 1 ♀, Brisbane, September, A. P. Dodd.

The hairs of the body appear to have a greenish tinge, more noticeable on the occiput and thorax, the general colour being a golden yellow tinged green.

The holotype and allotype are in the Queensland Museum.

Dischistus pallidoventer, n. sp.

♂. The head is mainly grey; occiput somewhat flattened above, more convex below, clothed with dense, pale yellow hairs, with a distinct fringe of longer, similar hairs above and contiguous with the posterior eye-margins. Eyes contiguous from immediately below the ocellar tubercle to near the antennal triangle. Frontal triangle rather small, clothed with appressed, golden pile and some short, black hairs; face projecting between the eyes, clothed with dense, soft, pale yellow hairs, which become extremely pale on the lower third of the cheeks and chin, forming a pale, shining beard; between the upper mouth borders and the base of the antennae are some dense, erect, black hairs encircling the yellow hairs of the face for a short distance; mouth opening rather narrow. Proboscis short and slender, little more than twice the length of the mouth opening; palpi small and very slender, black. Antennae as long as the head, approximate, though

distinctly separated at the base, black, with greyish reflections; the first segment is rather short, about equal in length to the second, both first and second segments with dense black hairs; the third is longer than the first two segments together, somewhat oval in shape, being broad medianly and tapering from thence to the blunt apex; style distinct and subapical.

Thorax black, clothed with appressed, bright golden scales and dense, erect, short and equal, pale yellow hairs, with numerous intermixed black and pale, bristly hairs; notopleural bristles short and black; scutellum black, clothed like the thorax, with long, thin, black bristles; pleurae and breast greyish, clothed with very pale yellow hairs, the mesopleural tuft darker above and below the wing; squamae brownish with a yellow fringe; halteres with slender, brownish stems and blackish knobs.

Abdomen elongate and conical in shape, as long as the head and thorax together, jet-black, and somewhat shining on the anterior margins of the segments, and narrowly pale reddish on the extreme lateral margins; the whole is clothed with appressed, shining golden scales and erect, yellowish hairs; the bristles are thin and black, and form complete rows on the posterior borders of the segments; there is a distinct band of erect, short, pale yellow hairs on the basal segment, which is continued laterally, and across the anterior border of the second segment a narrow band of white hairs, this segment also bearing pale yellow hairs on its sides; the venter is very pale greyish, clothed with appressed, dense, shining, pale hairs, densest and longest laterally.

Legs mainly yellow, the coxae greyish and the apical tarsi dark brown, clothed with pale scales, these scales being white beneath the hind femora and tibiae; femora with long, pale hairs beneath; pulvilli pale; spines black.

Wings long and narrow, the alula much reduced, subhyaline, but brown at the base and along the fore margin for the whole of its length, and more than one-third but less than one-half the breadth, the colour being rather paler near the apex; cell mc rather narrow, the vein r-m being placed well beyond its middle; R_{2+3} curved so as to meet the costa at a right angle.

Length of body, 9·5 mm.; of wing, 10 mm.

Holotype ♂, Hobart, Tasmania, 14th March, 1917, G. H. Hardy.

Paratypes: 1 ♂, Hobart, 10th March, 1917, G. H. Hardy; 3 ♂, Chelsea, Victoria, L. B. Thorn, 5th April, 1910, and 16th March, 1919; 1 ♂, Blue Mts., N. S. Wales, 26th February, 1922, E. W. Ferguson; 1 ♂, National Park (Gundamain), N. S. Wales, 4th April, 1925, I. M. Mackerras.

The holotype is in the Queensland Museum.

Dischistus perparvus, n. sp.

♂. Head mainly blackish-grey; occiput little convex, silver grey laterally, clothed with short, dense, equal whitish hairs. Eyes contiguous for about one-third the length of the frons, their upper facets distinctly enlarged; ocellar tubercle black, with some long, bristly black hairs. Frontal triangle large, with a rather indistinct median groove; face little prominent, clothed with erect black hairs; mouth opening with grey borders, not very long or broad; chin grey-black, with a sparse, pale brownish beard. Proboscis very elongate and slender, almost three times the length of the head, with little enlarged labella; palpi extremely short, brownish, with sparse white hairs. Antennae not as long as the head, segments one and two greyish, the third black; first segment not quite twice as long as the second, with long black hairs; the third about as long as the first and second together, strap-shaped, with a minute, subapical, spine-like style.

Thorax black, clothed with short, dense, equal, pale brownish hairs which, viewed from the front, appear whitish laterally, and appressed thin, golden scales, with intermixed pale and dark bristly hairs; scutellum similarly covered, with longer pale or whitish bristles; pleurae and breast rubbed, but the pleurae appear to be clothed with brownish hairs and the breast with intermixed black hairs; halteres pale brown with much enlarged black knobs; squamae pale, with an exceedingly short and sparse whitish fringe.

Abdomen black, short and rounded, hardly as long as broad and about as broad as the thorax, covered with appressed thin, golden scales and scattered, erect, whitish, bristly hairs; the first segment bears a distinctive band of dense, whitish hairs; on the posterior border of the same segment, overlapping on to the second segment is a narrow band of silvery white, appressed tomentum, rather thin laterally; laterally, the abdomen is clothed with sparse white hairs, densest and shortest basally, the third to the apical segments bearing depressed, white pile, which encroaches on the dorsum for a short distance along the anterior borders of each segment, becoming more conspicuous apically; venter thinly white pollinose.

Legs with the coxae blackish, the fore femora reddish, the middle femora reddish, pale brown apically, the hind femora and all tibiae pale brown, the whole clothed with white scales, which, in certain lights, appear brownish beneath; hind femora with some long, black spines beneath.

Wings stout and hyaline, black at the base and along the fore margin to the apex of cell Sc, the colour faintly present in cell M and around the vein r-m.

Length of body, 6 mm.; of wing, 6 mm.

Holotype ♂, Morven, Queensland, September, 1927, A. P. Dodd.

The holotype is unique and is in the Queensland Museum.

According to White, three further species apparently belong to this genus, these species being *antecedens*, *altus*, and *immutatus*, all of which were described by Walker. Macquart's *crassilabris*, placed by Hardy among the species of *Dischistus*, I have identified as a species in which the palpi are two-jointed and therefore not belonging to the Bombyliinae.

None of the three former species has been recognized, their original descriptions being appended herewith in this genus on the authority of White.

DISCHISTUS ANTECEDENS (Walker).

Bombylius antecedens, Walker, *List Dipt. Brit. Mus.* ii, 1849, 293.—*Dischistus antecedens*, Hardy, *Proc. Roy. Soc. Tasm.*, 1923, 83.—*Sisyromyia antecedens*, Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 72.

"Mas. Niger, pilis canis vestitus, capite setis nigris armato, antennis pedibusque nigris, alis subcinereis.

"Body black, thickly clothed with long shining hoary hairs; eyes red; front and clypeus thickly beset with black bristles; mouth much more than half the length of the body; lips black; feelers black; first joint linear, second joint not half the length of the first; third joint much longer than the first and second, straight beneath and forming an obtuse angle above, where it is furnished with some long black hairs; legs black, clothed with some very short black hairs; wings tinged with grey; fore border slightly tinged with tawny colour; wing ribs and veins piceous, the latter black towards the tips; poisers yellow, very long with black knobs.

"Length of body 2 lines; of the wings 5 lines.

"New Holland".

Dischistus altus (Walker).

Bombylius altus, Walker, *List Dipt. Brit. Mus.*, ii, 1849, 288.—*Bombylius pinguis*, Walker, *List Dipt. Brit. Mus.*, ii, 1849, 290.—*Sisyromyia altus*, Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 72.—*Sisyromyia pinguis*, Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 72.—*Dischistus altus*, Hardy, *Proc. Roy. Soc. Tasm.*, 1923, 83.

"Fem. Cinereus, pilis fulvis et nonnullis rufis nigrisque vestitus, subtus albo pilosus, antennis nigris, pedibus ferrugineis, tarsis piceis, alis cinereis basi et ad costam fulvis.

"Body grey; head clothed with tawny hairs, and having a few black hairs on the crown; underside thickly clothed with white hairs; feelers and mouth black, the latter about half the length of the chest; chest very thickly clothed with short white tawny hairs, which are paler on each side as they approach the white hairs of the breast; the sides are also adorned with red hairs, and a few red and black hairs scattered over the chest and breast; abdomen thickly clothed with tawny hairs, which are very bright on each side towards the tip; its back is thinly clothed with black hairs, which are most frequent at the tip; the underside, with the exception of the sides and tip, is clothed with white hairs; legs ferruginous covered with a hoary bloom and clothed with short whitish hairs and a few black bristles; feet piceous towards the tips; wings grey, tawny at the base and along the sides of the veins of the fore borders for three-quarters the length; wing ribs ferruginous; veins piceous, black towards the tips; poisers ferruginous, with yellow tips.

"Length of the body, 5 lines; of the wings, 14 lines.

"Swan River".

Dischistus immutatus (Walker).

Bombylius immutatus, Walker, *List Dipt. Brit. Mus.*, ii, 1849, 292.—*Sisyromyia immutatus*, Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 72.—*Dischistus immutatus*, Hardy, *Proc. Roy. Soc. Tasm.*, 1923, 83.

"Mas. Niger, pilis flavis vestitus, antennis femoribusque nigris, tibiis ferrugineis, tarsis piceis, alis limpidis basi costaque fulvis.

"Body black, with a grey bloom, most thickly clothed with pale yellow hairs; there are a few black hairs on the crown of the head which is covered with more and longer black hairs about the base of the feelers; the latter are black, the third joint slightly tapering from the base to the tip and rather shorter than the first and second; mouth black, as long as the chest; palpi also black and more than one-third the length of the mouth; eyes dark red with a bronze tinge; legs ferruginous, with a few black bristles which are mostly on the shanks; hips and thighs, excepting the tips of the latter, black and covered with a hoary bloom; feet hairy piceous; wings colourless, tawny at the base and along the fore borders for two-thirds the length; wing ribs and veins tawny, the latter black towards the tips; poisers tawny, the knobs mostly piceous.

"Length of the body, 4 lines; of the wings, 10 lines.

"West Australia".

It appears to me that *altus*, *immutatus*, and *crassilabris* are synonymic. The former two species, however, were described from Western Australia, and as yet I have no record of the species I have determined as *crassilabris* from this State. Under these conditions, it seems best to follow White until more material is made available.

BIOLOGICAL LABORATORY LIBRARY

A NEW BUPRESTID FROM AUSTRALIA.

By A. Théry.

(*Communicated by H. J. Carter.*)

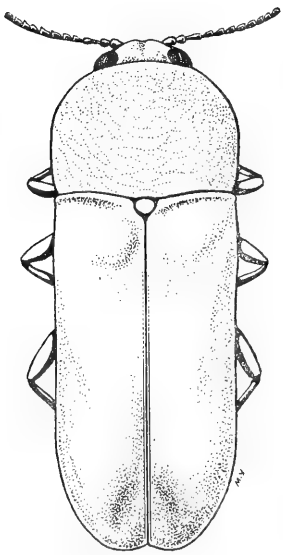
(One Text-figure.)

[Read 26th September, 1928.]

Mastogenius frenchi, n. sp.

Length, 2·75 mm.; width, 1 mm.—Elongate, nearly parallel, covered with very short and fine pubescence; entirely black.

Head convex, longitudinally impressed in front, above the clypeus strongly and sparsely punctured with the interspaces alutaceous; eyes large, nearly parallel, not projecting and partially covered by the pronotum; clypeus depressed below the level of the forehead, broad, nearly truncate; antennae rather long, serrated from the fourth joint, the first two joints very full, the rest slender, the third slightly longer than the second and equal to the following, the serrated joints with some erect hairs.



Mastogenius frenchi, n. sp. (× 25.)

Pronotum very convex, widest at the anterior third, without impressions; the apex straight and finely bordered, the sides arcuate and narrowed in front, very feebly arcuate behind; the posterior angles obtuse; the sides with two lateral carinae, well separated, slightly sinuate and not united before or behind. The base straight and bordered (when the pronotum is inclined) by a shining band serrated posteriorly as in the genus *Ptosima*. Disk punctured in middle, covered laterally and posteriorly with fine, concentric and superficial ridges.

Scutellum flat, nearly triangular, with all the angles rounded.

Elytra without humeral callus, only a little larger at the humeri than the pronotum is at base, sides straight to the apical fourth, then abruptly rounded at the apex, with an obtuse sutural angle; base bordered by a depressed carina separated from the disk by a well marked furrow; on the anterior fourth, on each side near the suture, is a feebly accentuated hump, and near the apex a small depression on each elytron; the suture depressed anteriorly and carinated on the posterior half; the sides bordered from the epipleural lobe, which is large and carinated, to the apex; the humeral carina as long as the lobe. Disk punctured on a glossy ground, the punctures distinctly seriated, the apex rugose. Some examples show the pygidium concave in the

middle and terminated by a thin translucent plate; this is probably a sexual character.

Prosternum convex, with the anterior margin largely and arcuately sinuous and finely bordered; the surface evenly punctured, the punctures regularly spaced, rather deep, intermingled with hairs; prosternal process large, subtruncate at apex, not narrowed between the coxae, plainly punctured, not bordered. Meso-metasternal suture entire and very distinct; the sternal cavity formed entirely by the mesosternum; the anterior margin of the metasternum rounded, only touching the sternal cavity in a single place where the mesosternum is nearly divided. Whole surface plainly punctured. Posterior coxae scarcely enlarged interiorly, not at all exteriorly. Metathoracic episterna partially covered with epipleural lobe of the elytra which is well developed. First and second ventral segments united much longer than the three following together; the suture between the first two segments almost invisible and not at all parallel to those of the other segments. The second segment not longer than the third. Last segment short, broadly rounded and coarsely punctured at apex, without marginal furrow. On the first segment, the punctation is squamose, on the rest similar to that of the metasternum; the intercoxal process of abdomen is short and acute, rounded at the apex. The pubescence of the under side is rather long and not very dense. The abdominal episterna are limited only by a fine carina from the middle of the sides of the first segment, without any furrow. Tibiae straight, the posterior finely ciliated with yellowish hairs; tarsi strongly compressed, the joints short and subequal, the claws simple (or lobed only at base).

Described from four specimens from Victoria, Australia (captured by C. French). The type and a paratype are in my collection, one paratype in that of the British Museum, the other in Mr. H. J. Carter's collection.

FOSSIL PLANTS FROM THE ESK DISTRICT, QUEENSLAND.

By A. B. Walkom, D.Sc.

(Plates xxvi-xxviii; four Text-figures.)

[Read 26th September, 1928.]

The fossil plants described in this paper comprise two collections, one made by Messrs. J. H. Reid and C. C. Morton of the Queensland Geological Survey during their geological examination of the district, and the other by Professor H. C. Richards, Dr. W. H. Bryan and a small party of students from the University of Queensland during a geological excursion to the district. These collections supplement those previously described from the Esk Series (Walkom, 1917*a*, 1917*b*, 1924). Several species are described as new, and others are recorded for the first time from the Esk Series. The following is a list of species dealt with here:—

Cladophlebis lobifolia (Phillips)
Cladophlebis australis (Morris)
Todites Williamsoni (Brongn.)
Thinnfeldia eskensis, n. sp.
Thinnfeldia talbragarensis Walkom
Thinnfeldia lancifolia (Morris)
Danaeopsis Hughesi Feistmantel
Asterotheca Denmeadi, n. sp.
Pecopteris (*Asterotheca*) *Hillae* Walkom
Taeniopteris crassinervis (Feistmantel)
Taeniopteris Tenison-Woodsi (Etheridge Jr.)
Neuropteridium moombraense, n. sp.
Sphenopteris eskensis, n. sp.
Sphenopteris superba Shirley
Anthrophyopsis grandis, n. sp.
Nilssonia eskensis, n. sp.
Nilssonia Reidi, n. sp.
Nilssonia Mortoni, n. sp.
? Pterophyllum Nathorsti (Seward)
Pseudoctenis eathiensis (Richards)
Ginkgoites cf. *magnifolia* Fontaine
? Ginkgoites sibirica Heer

Of this list, *Thinnfeldia eskensis*, *Asterotheca Denmeadi*, *Neuropteridium moombraense*, *Sphenopteris eskensis*, *Anthrophyopsis grandis*, *Nilssonia eskensis*, *Nilssonia Reidi* and *Nilssonia Mortoni* are described as new, while the following additional species had not previously been described from the Esk Series:—*Todites Williamsoni*, *Thinnfeldia talbragarensis*, *Danaeopsis Hughesi*.

Todites Williamsoni occurs in rocks of Upper Triassic age in various parts of the World, but has not hitherto been recorded from Australia. *Thinnfeldia talbragarensis*, a species intermediate between *T. lancifolia* and *T. Feistmanteli*, was first described from the Jurassic rocks at Talbragar, N.S.W., and may be expected in any rocks where both the species mentioned are found; *Danaeopsis Hughesi* has been described previously from the Ipswich Series.

Of the species described as new, those which may be used for correlation with floras in other parts of the World confirm previous determinations of the age of the Esk Series as Upper Triassic (possibly Rhaetic). *Thinnfeldia eskensis* is closely allied to some specimens of *T. rhomboidalis* from the Rhaetic of Nurnberg; *Asterotheca Denmeadi* is similar to *A. Cottoni* from the Rhaetic of Tonkin; *Neuropteridium* is a genus occurring in Triassic floras of Europe and Permo-Carboniferous floras in India, South Africa and South America; and *Anthrophyopsis grandis* is similar to species occurring in the Rhaetic of Greenland and Sweden.

In a recent analysis of the flora of the Upper Karroo Beds of South Africa, Du Toit (1927) has studied carefully the ages of so-called "Rhaetic" floras, particularly where they occur in association with beds containing marine faunas. He confirms (p. 313) the correlation of the Queensland Ipswich Series with the South African Molteno Beds, and he regards the Molteno Flora as essentially of Upper Triassic (Keuper) age.

CLADOPHLEBIS LOBIFOLIA (Phillips).

Examples of this species have been described and figured (Walkom, 1924, p. 81, Pl. xv) from two localities in the Esk District. An additional specimen* (No. 1925, Q.G.S.) is here recorded from Coal Creek, 6 miles NNE. of Esk.

CLADOPHLEBIS AUSTRALIS (Morris). Plate xxvi, fig. 1.

Sterile examples of this type of frond are abundant at a locality on the road between Bellevue and Esk, and are mentioned in the description of *Todites Williamsoni* below.

TODITES WILLIAMSONI (Brongniart). Plate xxvi, figs. 1, 2.

Portions of fertile pinnae belong to this widespread Upper Triassic and Jurassic type of fern. In the specimens from the Esk Series the pinnae are long, linear, up to 1·1 cm. wide; the rachis is 1 mm. wide and the pinnules alternate, short, and obtuse, at the lower margin being convex and at the upper concave, 5 mm. long by 4 mm. wide. The sori cover practically the whole surface of the pinnule (Plate xxvi, fig. 2).

Specimens which appear indistinguishable from this species have been frequently described and figured from rocks of Upper Triassic and Jurassic ages, under a variety of specific names (for references see Seward, 1910, pp. 339-343).

The distinctions between described species of *Todites* are not very clear, and in the absence of well preserved sporangia it is hopeless to try and distinguish them. The present examples are referred to *T. Williamsoni*, since the fertile pinnae agree very closely with figured examples of that type both in the characters of the pinnules and in the distribution of the sporangia.

Further references to some of the species are to be found in papers by Gothan (1914), Johannson (1922) and Harris (1926).

The species occurs in Upper Triassic rocks in South Africa, Switzerland and Virginia and in rocks classed as Rhaetic in Tonkin, Greenland and Germany.

Closely associated with these fertile fronds are numerous sterile fronds which belong to the *Cladophlebis australis* type, and it seems more than probable that the two belonged to the same fern. In the sterile examples the pinnules are considerably larger than in the fertile.

Locality.—Road between portions 70 and 76, Parish Wivenhoe (F1728, U.Q.).

THINNFELDIA ESKENSIS, n. sp. Plate xxvii, fig. 2; xxviii, fig. 1.

Frond large, with strong, striated rachis. Pinnules large, robust, gradually tapering to rounded acute apex; upper half of lamina contracting at base, lower half broadening slightly and somewhat decurrent; midrib prominent becoming evanescent near apex; secondary veins make an acute angle (20°-25°) with midrib

* The registered numbers of the specimens in the two collections described are distinguished by the letters placed after the figures. Q.G.S. = Queensland Geological Survey; U.Q. = University of Queensland.

and divide, usually only once; a small number of veins at the base of the pinnule spring direct from the rachis.

In the largest specimen examined the frond is 24·5 cm. long and about 12 cm. broad, with the rachis 3 to 4 mm. broad; the pinnules are as much as 7 cm. long and 1·5 cm. wide.

In the specimens available the frond is simply pinnate and none shows a dichotomising rachis like the other Australian species of *Thinnfeldia*. It may be, however, that further collecting will produce more complete specimens, and this species may agree with the others in this character.

Among Australian species *T. eskensis* may be compared with *T. narrabeenensis* from the Narrabeen Beds of the Hawkesbury Series of New South Wales. In general appearance it is not so robust as the New South Wales species, the rachis not being so prominent and the pinnules being generally narrower in comparison with their length. The secondary veins also make a somewhat more acute angle with the midrib. In addition, no information is available as to the nature of the pinnules towards the base of the frond in *T. eskensis*.

The present species seems distinct from specimens described as *Danaeopsis Hughesi* from the Ipswich Series in the much smaller size of the pinnules and in the venation, the secondary veins being not so close together and making a much more acute angle with the midrib. In *D. Hughesi* the veins make an average angle of about 45° with midrib, in *T. narrabeenensis* about 30°, and in *T. eskensis*, 20°-25°. The pinnules of *T. eskensis* are not as narrow and pointed as those of *T. acuta*.

The species to which these specimens show closest resemblance is the large form of *T. rhomboidalis* described and figured by Gothan (1914) from the Rhaetic of Nurnberg, with which it may even be identical. It is interesting to find specimens of *Thinnfeldia* which appear to be practically identical, from the Northern and Southern Hemispheres. A considerable amount has been written on the genus *Thinnfeldia* (Gothan, 1912, 1914; Antevs, 1914; Walkom, 1917*a*), and, with the exception of the Nurnberg examples, there appeared to be a distinct difference between the European species and those of the Southern Hemisphere (Australia, South Africa and South America). The specimens from the Esk Series, therefore, may lead to a better understanding of the relation between Northern and Southern species referred to *Thinnfeldia*.

Localities.—Road between portions 70 and 76, Parish Wivenhoe (F1733, U.Q.), Moombra (1939, Q.G.S.), Schultz's Selection, Coal Creek (1929, Q.G.S.).

THINNFELDIA TALBRAGARENSIS Walkom. Plate xxvii, fig. 1.

Mem. Geol. Survey, N.S.W., Pal. No. 12, 1921, p. 9.

This species, intermediate between the two types *T. Feistmanteli* and *T. lancifolia*, was first described from the Jurassic rocks of Talbragar in New South Wales. A specimen closely comparable with this species has since been recorded from Mesozoic (probably Rhaetic) rocks in Tasmania (Walkom, 1925*b*), and now, among the plants collected in the Esk District, further examples are noted from Portion 366, Pine Mountain (No. 1932, Q.G.S.), the Moore-Benarkin Rd. (No. 1938, Q.G.S.) and the top of Wivenhoe Range, Bellevue (F1732, U.Q.).

It is not at all surprising to find this extended range for *T. talbragarensis*; indeed, in view of the probability of its close relation with the other species of *Thinnfeldia*, one would expect to find it in association with the two species above-mentioned at any locality where they are present.

THINNFELDIA LANCIFOLIA (Morris).

This species is represented by a good example on specimen F1731 (U.Q.) from Sheep Station Creek, near Wivenhoe Crossing of Brisbane River.

DANAEOPSIS HUGHESI Feistmantel.

This species also occurs at Denmark Hill, Ipswich, in beds belonging to the Ipswich Series (see Walkom, 1917*a*, p. 24). It occurs among the collections from near Moombra School (No. 1916, Q.G.S.).

ASTEROTHECA DENMEADI, n. sp. Text-fig. 1.

Frond bi- (? tri-) pinnate. Pinnules (fertile) attached by whole base, almost at right angles to rachis, traversed by prominent midrib from which a number of secondary veins are given off obliquely. Apex of pinnules acuminate. Rachis striated longitudinally. Sori arranged on either side of midrib, about ten on each pinnule. Sorus composed of 3-6 (usually 4) sporangia, apparently united by proximal end to a central receptacle, free at their distal ends. Dehiscence possibly by longitudinal slit.

The pinnules are about 1·2 cm. long and 3-4 mm. wide. The nature and arrangement of the sori indicates the affinity of the specimens with species of *Asterotheca*. In having the sporangia united only in the basal region and free towards their apical end, the sorus shows closest resemblance to that of species of *Hawlea* (Stur, 1885, p. 106; Seward, 1910, p. 400, fig. 291F), which genus is considered to be congeneric with *Asterotheca* (Bower, 1908, p. 522; Seward, l.c.). In many of the individual sporangia parts of the wall may be seen to have been composed of thin walled elongated cells, and in view of the fact that this can be seen in such a large number of the sporangia and also that in no case were any thick-walled cells suggesting an annulus observed, it does not seem unreasonable to suggest that the sporangia had no distinct annulus. Further, many of the sporangia have a distinct longitudinal mark which may represent a slit along which dehiscence took place (see Text-fig. 1, *c*, *d*).

In *Dactylotheca* the sporangia are not united as in *Asterotheca*.

Our species is of similar size to *A. Cottoni* from the Rhaetic of Tonkin (Zeiller, 1903, Pl. 1, figs. 4-9), but the sori are not so crowded and do not cover such a large proportion of the surface of the pinnule. The sori in *A. Cottoni* also appear to be more compact than in *A. Denmeadi*. A very close resemblance may be noted to a species of *Hawlea* figured by Stur: the general appearance of the pinnule and arrangement of sori and sporangia agree very closely with Stur's figure of *H. Miltoni* (Stur, 1885, p. 108, Pl. lix, lx). This species, referred to *Pecopteris* (*Asterotheca*) *Miltoni* by Seward (1910, p. 399) is a common Coal Measure form in Europe.

A. Denmeadi is a much larger species than *Pecopteris* (? *Asterotheca*) *Hillae* previously described from the Esk Series (Walkom, 1924, p. 82, Pl. 17, figs. 1-3). In *P. Hillae* very little detail of the structure of sori or sporangia was observable but there is little doubt that it was quite distinct from the species here described as new.

Locality.—Road between portions 70 and 76, Parish Wivenhoe (F1726-7, U.Q.).

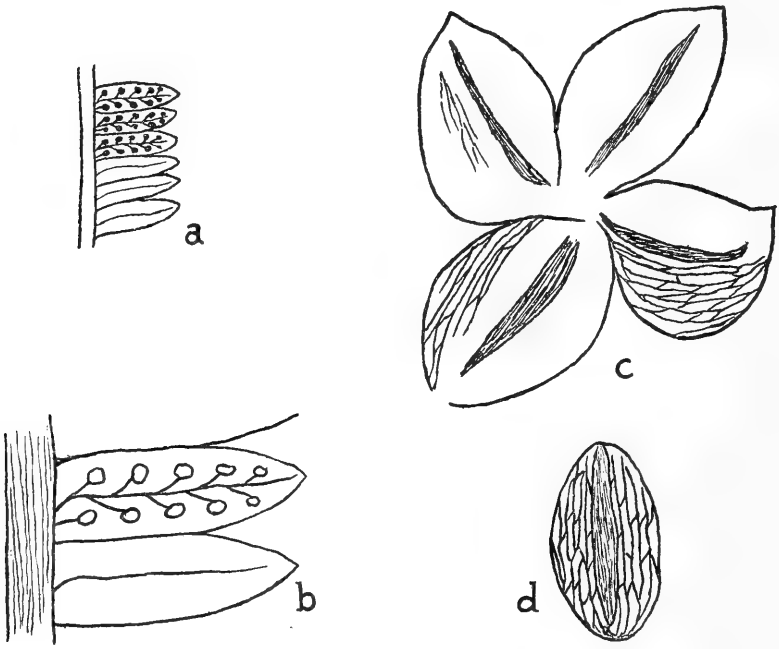
PECOPTERIS (? ASTEROTHECA) HILLAE Walkom.

This interesting species was described at some length among a series of specimens belonging to the Queensland Museum (Walkom, 1924, p. 82), and the

Geological Survey Collection contains specimens from the same locality, Portion 42, Parish of Wivenhoe.

TAENIOPTERIS CRASSINERVIS (Feistmantel). Plate xxviii, fig. 6.

Specimen No. 1936 (Q.G.S.) does not agree well with examples of *T. crassinervis* previously described from Queensland, but in view of a fairly wide variation in that species, as exemplified by specimens figured from New Zealand (Arber, 1917, p. 45, Plate x), it seems wisest to refer the specimen under consideration to this species. The specimen has been a good deal broken during fossilization



Text-fig. 1.—*Asterotheca Denmeadi*, n. sp. *a*.—Portion of frond, nat. size. *b*.—Portion of frond, enlarged (× 3). *c*.—Sorus, viewed from above (× 35). *d*.—Sporangium (× 25).

and its length is indeterminable. The width is 4·5 cm. and the base is cordate; the midrib is about 2·5 mm. wide and the veins are at right angles to the midrib and 1 to 1·5 mm. apart; they divide occasionally and sometimes the two branches join again, making a small loop in the vein; apart from this, two adjacent veins occasionally join.

There does not seem to be any good ground for separation from *T. crassinervis*. Arber described the base of the New Zealand specimens as "suddenly contracted", and little variation of this is needed to make the base cordate, if the form of the base in the Queensland specimen is natural and not due to distortion (as may possibly be the case). The specimen came from Portion 42, Parish of Wivenhoe, a locality where other examples of *T. crassinervis* have been collected.

TAENIOPTERIS TENISON-WOODSI Etheridge Jr.

Specimens referred to this species show some variation from the examples previously described. They are slightly wider, have a wider midrib and the veins are not quite so close together. There does not, however, appear to be sufficient ground at present for giving them a separate specific name.

It might be pointed out here that in my description of this species (1917*a*, p. 33) an error has been noted in the second line where the width is stated to be up to 8 cm.; this should read 8 mm.

Examples in the collection come from the Railway Cutting at Overbridge, Ottaba (No. 1924, Q.G.S.), near Esk (1928, Q.G.S.), and from ¼ mile west of Esk Post Office.

NEUROPTERIDIUM MOOMBRAENSE, n. sp. Plate xxvii, fig. 4.

Frond pinnate; upper pinnules elongate, with lobed margin, and midrib which does not persist to apex; lower pinnules rhombic in outline, attached at one of the acute angles, veins diverging from base; pinnules contracted at base and attached by contracted portion, the lower margin being decurrent.

Specimen No. 1937 (Q.G.S.) is different from any that I have previously examined from Australian rocks, and it agrees best with *Neuropteridium*, a genus which includes Triassic European species as well as some Permo-Carboniferous plants.

In general appearance there is a considerable degree of resemblance to *N. validum* which occurs in the Lower Gondwana rocks of India and in the Permian (Permo-Carboniferous) of South America and South Africa. The pinnules are, however, notably different in shape, being much more acute at apex and more acutely contracted towards the base, a condition which results in the lower pinnules being markedly rhombic in outline and not rounded or semicircular.

The specimens are among those from the Road just south of Moombra School.

SPHENOPTERIS ESKENSIS, n. sp. Plate xxvi, fig. 3; Text-fig. 4.

A specimen with seven or eight broadly wedge-shaped leaves which, from their disposition, appear to have been attached to an axis, differs from any specimen yet found in the Australian Mesozoic rocks. It may represent a new generic type, but in the absence of sufficient information for a complete diagnosis, it is referred to the form genus *Sphenopteris* on account of the shape of the individual pinnules and their venation.

Pinnules wedge-shaped, 1·5 cm. from base to outer margin, which is slightly crenulate, traversed by a small number of radiating dichotomously branching veins.

The disposition of the pinnules, as seen in the figure, at once suggests attachment to an axis and comparison in form with such genera as *Adiantites* and *Rhacopteris* which are of common occurrence in Carboniferous rocks. Attention may be drawn in this connection to figures of *Adiantites adiantoides* L. & H. (Kidston, 1923*a*, Pl. xlv. fig. 3) and *Rhacopteris inaequilatera* and *R. Lindseaeformis* (Kidston, 1923*b*, Pl. xlix, 1), and *R.* sp. (Seward, 1910, p. 427) in all of which, however, the veins are considerably more numerous than in our specimen.

Single pinnules also resemble in general appearance some species of *Protorrhipis* or *Hausmannia*, described by Nathorst, but the absence of any trace of the reticulate venation of those species separates our specimen from them.

The only figure resembling *S. eskensis* which I have been able to find among Mesozoic species is that described by Feistmantel as *Cyclopteris pachyrhachis* Gopp. from the Panchet Group of the Raniganj coalfield in India (Feistmantel,

1880, p. 84, Pl. 17*a*, fig. 7). The Panchet Group has been correlated with other beds as of Triasso-Rhaetic age by Arber (1905). The generic name *Cyclopteris*, however, is no longer used, it having been instituted originally for modified leaves belonging to *Neuropteris* and *Odontopteris*, and it seems likely that Feistmantel's specimen is similar to that here described from Esk.

Locality.—Railway Cutting, near Ottaba Railway Station (F1729, U.Q.).

SPHENOPTERIS SUPERBA Shirley.

Some fine examples of this species (F1730, 1731, U.Q.) have been obtained from Sheep Station Creek, near Wivenhoe Crossing of Brisbane River.

ANTHROPHYOPSIS GRANDIS, n. sp. Plate xxvi, fig. 5; Text.-fig. 2.

Frond large, apex obtuse; midrib prominent, gradually becoming finer and not persisting to apex; secondary veins first at about 45° to midrib, curving outward to 70° with midrib, forming wide elongate polygonal mesh for about one-third width of lamina, and then narrower elongate mesh.

The genus *Anthrophyopsis*, originally described by Nathorst, was later suppressed by him and all the species transferred to other genera. Recently Harris (1926) has proposed to reinstate the genus, with the two species *A. Nilssoni* and *A. crassinervis*, the former being the genotype. The structure of the cuticle of upper and lower surfaces is the more important part of Harris's description, but an attempt to isolate the cuticle of our specimens was unsuccessful. However, the venation is quite characteristic and little hesitation is felt in referring the specimens from the Esk district to this genus. The specimens give a good idea of the form of the leaf, which was previously little known.

The leaf as preserved is incomplete at the basal end, but is a handsome one, 15 cm. long and 9·5 cm. wide. The apex is very broadly obtuse, the lamina being 3·5 cm. wide at a distance of 1 cm. from the apex. The margin is somewhat irregular, being divided by indentations of varying depth. The midrib is relatively fine and distinct, some 2 mm. broad at the base of the leaf and gradually becoming thinner until it disappears about 3 mm. before reaching the apex. The secondary veins leave the midrib at an acute angle and for about one-third of the width of the lamina they form a wide elongate mesh with a general inclination of about 45° to the midrib; for the remainder of the lamina they form a narrower elongate mesh inclined at about 65° to 70° to the midrib; in the inner part the meshes are 1-2 mm. wide, wider in the basal part than the apical, while in the outer part they approximate to 7 or 8 meshes in 5 mm. of width.

In the figures of *A. crassinervis* given by Harris (1926, Pl. viii, figs. 1, 2) there is not the same difference in width of the meshes in the inner and outer parts of the leaf, though there is a distinct difference in the length of the meshes in the two zones. The same applies to Nathorst's figures of (*Ctenis*) *fallax* (1878-86, Pl. vii, fig. 3, Pl. xi, fig. 6, Pl. xix, fig. 5); the two last-mentioned figures give the impression that the meshes are shorter in the outer zone than the inner, whereas in our specimens the reverse is the case.

Nathorst's *A. obovata* (1878, Pl. 2, fig. 2) is a smaller form than ours, and the secondary venation makes a more acute angle with the midrib.

All the known species have been found in rocks of Rhaetic age, *A. Nilssoni* in the Rhaetic floras of Bjuf and Hoganas, and *A. crassinervis* in the Rhaetic of Scoresby Sound, Greenland and Bjuf.

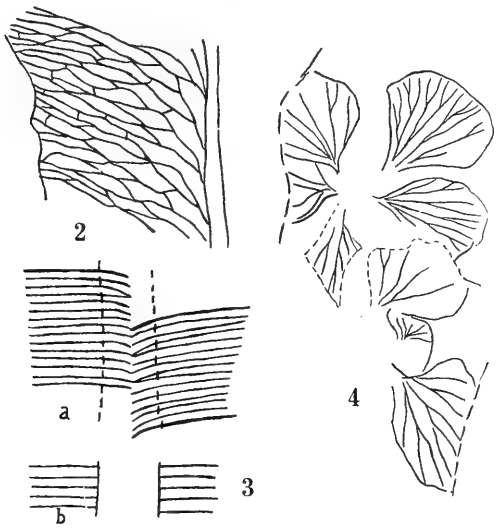
Locality.—Sheep Station Creek, near Wivenhoe crossing of Brisbane River (F1724-5, U.Q.).

NILSSONIA ESKENSIS, n. sp. Plate xxvi, fig. 4; Text-fig. 3.

An example similar in general appearance to *Pterophyllum contiguum* differs from that species in having the pinnae attached to the upper surface of the rachis, and also in the venation, the veins dividing but rarely.

The lamina is divided into distinct segments, irregular in their width, varying from 2·5 to 4·5 mm. wide, and 2·5 cm. long. The rachis is about 2 mm. wide and the veins fine, about 3 per mm., and rarely branching.

Specimen 1920 (Q.G.S.), of this species, is from Portion 85, Parish Esk.



Text-fig. 2.—*Anthrophyopsis grandis*, n. sp. Camera lucida sketch of venation. Nat. size.

Text-fig. 3.—*Nilssonia eskensis*, n. sp. Sketch showing attachment of pinnae to rachis, and the venation. *a*, from above; *b*, from below (× 3½).

Text-fig. 4.—*Sphenopteris eskensis*, n. sp. Camera lucida sketch showing venation of leaves and possible arrangement of leaves about an axis, as in *Rhacopteris*. Nat. size.

NILSSONIA REIDI, n. sp. Plate xxviii, figs. 4, 5.

Frond simple; about 7 cm. wide. Lamina divided irregularly into segments from 0·4 to 1 cm. wide, attached to upper surface of rachis. The veins are straight, at right angles to apex, fine (20-25 per cm.) and rarely branching.

This species is similar in general form to *Pterophyllum multilineatum*, already recorded from the Ipswich Series, but differs in the mode of attachment of the lamina to the rachis, which, so far as known, is lateral in specimens referred to *P. multilineatum*, and also in the venation, the veins dividing comparatively frequently in the latter species. In general appearance it also suggests *N. princeps* occurring in the Jurassic of the Indian region, but is not so large and has finer venation. Comparison may also be made with some examples of *N. compta*, e.g. that figured by Seward (1900, p. 227, fig. 40), but in this case also our species is not so large and has the veins closer together.

Locality.—Chaillé's Windmill, Paddy's Gully Rd. (Nos. 1918, 1919, Q.G.S.).

NILSSONIA MORTONI, n. sp. Plate xxviii, figs. 2, 3, 7.

Frond simple, breadth 6 cm., length ? (considerably more than 10 cm.), apex broadly obtuse, gradually tapering towards base. The lamina is attached to the upper surface of the rachis, and has the margins slightly lobed; it is entire or almost so, some specimens of the basal portion showing occasional division into broad segments. Rachis 2 mm. wide, tapering towards apex, longitudinally striated. Veins fine, numerous, 30-35 per cm., rarely dividing except near their point of attachment to rachis; the veins are at right angles to the rachis, except towards the apex of the frond, where they become inclined, making an angle as low as about 60°.

These leaves are quite different from any previously described from Queensland. They have a close resemblance to some of the species recorded from Jurassic rocks in other parts of the world, particularly *N. orientalis* (Heer.) as figured by Seward (1912, Pl. iii, fig. 46) from Afghanistan. A similar type of frond from Rhaetic rocks is *N. polymorpha*. In a number of these species of *Nilssonia* it appears quite impossible to distinguish between Rhaetic and Jurassic types.

Locality.—Road just south of Moombra School, about 7 miles SE. from Esk (Nos. 1914, 1915, 1917, Q.G.S.).

? PTEROPHYLLUM NATHORSTI (Seward).

This species has been described from Portion 28, Parish Biarra (Walkom, 1917*b*, p. 18) and the apical portion of a frond in the collection under description is doubtfully referred to it.

Locality.—Road between portions 70 and 76, Parish Wivenhoe (F1728, U.Q.).

PSEUDOCTENIS EATHIENSIS (Richards).

This species appears to be of fairly common occurrence in the Esk Series. *P. Footei*, from the Jurassic of India (Seward and Sahni, 1920, p. 33) is a very similar type, Feistmantel's specific name having been retained by Seward and Sahni only in view of the wide geographic separation.

Locality.—Wivenhoe (No. 1921, Q.G.S.).

GINKGOITES cf. MAGNIFOLIA Fontaine. Plate xxvii, fig. 3.

Queensland Geol. Survey, Pub. 259, p. 9, Pl. 4, f. 3, 4.

Additional large examples may be placed with that previously referred to under the above name. They are so unlike the Australian specimens which have been referred to *G. digitata* that it would seem better at present not to regard them all as conspecific. These examples are large (more than 11 cm. from base to outer margin) and have the veins about 1 mm. apart.

Locality.—¼-mile W. of Esk Post Office (No. 1934, Q.G.S.); Manyung Railway Station (No. 1935, Q.G.S.).

GINKGOITES (?) SIBIRICA Heer.

This species, previously recorded from Portion 24, Parish Esk (Walkom, 1924) has now been collected from Sheep Station Creek, near Wivenhoe Crossing of Brisbane River (F1731, U.Q.).

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EXPLANATION OF PLATES XXVI-XXVIII.

Plate xxvi.

1. *Cladophlebis australis* (Morris), sterile and *Todites Williamsoni* (Brongn.), fertiie. (× 0·8). Road between portions 70 and 76, Parish Wivenhoe, Q. (Spec. F1728, U.Q.).
2. *Todites Williamsoni* (Brongn.). Portion of fertile pinna shown in Fig. 1. (× 1·6).
3. *Sphenopteris eskensis*, n. sp. (× 1·6). Railway Cutting, near Ottaba Railway Station, Q. (Spec. F1729, U.Q.).
4. *Nilssonia eskensis*, n. sp. Natural size. Portion 85, Parish Esk, Q. (Spec. 1920, Q.G.S.).
5. *Anthrophyopsis grandis*, n. sp. (× ⅔). Sheep Station Creek, near Wivenhoe Crossing of Brisbane River, Q. (Spec. F1724, U.Q.).

Plate xxvii.

1. *Thinnfeldia talbragarensis* Walkom. (× ¾). Moore-Benarkin Road, Q. (Spec. 1938, Q.G.S.).
2. *Thinnfeldia eskensis*, n. sp. (× 0·7). Schultz's Selection, Coal Creek, Q. (Spec. 1929, Q.G.S.).

3. *Ginkgoites* cf. *magnifolia* Fontaine. (× 0·5). Manyung Railway Station, Q. (Spec. 1935, Q.G.S.).
4. *Neuropteridium moombraense*, n. sp. (× 0·8). Road at Moombra School, Q. (Spec. 1937, Q.G.S.).

Plate xxviii.

1. *Thinnfeldia eskensis*, n. sp. (× 0·5). Road between Portions 70 and 76, Parish Wivenhoe, Q. (Spec. F1733, U.Q.).
2, 3. *Nilssonia Mortoni*, n. sp. (2, × $\frac{2}{3}$; 3, × $\frac{3}{7}$). Moombra (Q.G.S. Collection).
4, 5. *Nilssonia Reidi*, n. sp. (× 0·5). Paddy's Gully Road, Q. (Spec. 1918, 1919, Q.G.S.).
6. *Taeniopteris crassinervis* (Feistmantel). (× 0·6). Portion 42, Parish Wivenhoe, Q. (Spec. 1936, Q.G.S.).
7. *Nilssonia Mortoni*, n. sp. (× 1·5). Portion enlarged, showing attachment of veins to upper surface of rachis. (Q.G.S. Collection).

THIRD CONTRIBUTION TOWARDS A NEW CLASSIFICATION OF AUSTRALIAN ASILIDAE.

By G. H. Hardy, Walter and Eliza Hall Fellow in Economic Biology, Queensland University.

[Read 26th September, 1928.]

Introduction.

About 80 years ago Loew laid the foundation for a classification of Asilidae, with three sections of subfamily rank; to these a fourth was added by Schiner. Various other writers have classified the Asilidae on this basis, either accepting or disregarding the fourth subfamily Leptogasterinae. Many of the papers made advances on Loew's work, but apparently the basis was accepted as more or less satisfactory; in other cases attention has been drawn to the unnatural status of the system which is now becoming more widely recognized as being quite inadequate for modern needs. Several authors have pointed out the impossibility of maintaining a distinction between Dasypogoninae and Laphriinae under the existing definitions, whilst others have apparently been satisfied with their status. On the whole no actual movement was made towards the betterment of the classification of the Asilidae.

Some of the more recent works have incorporated a study of the larvae and pupae and along these lines Melin seems to have achieved the nearest to a constructive criticism of the position. He pointed out that genera grouped under the Dasypogoninae are considerably more heterogeneous than those of the Laphriinae and Asilinae; the discrepancies in the larval characters are referred to in this respect and he then proceeds: "Now as the Dasypogonina flies and pupae do not show any great degree of accordance with one another either, I do not consider that what has hitherto been known as the Dasypogonina species can be brought together under one group ranking with the Laphriina and Asilina subfamilies. Instead of this they ought to be divided amongst several groups, which of course cannot be delimited in detail until some future date. With regard to the genus *Leptogaster* that is widely separated from most of the other Asilids not only through several imago characters . . . but also through several characters in their stages of development" (Melin, 1923, pp. 206-7).

Melin's criticism, based as it is upon biological grounds after about ten years' intensive study, must bear greater weight than any criticism levelled against it on general grounds, and to a great extent it justifies my action in gathering together the related Australian genera, showing affinities to each other, into groups, these groups being based upon characters of a fundamental nature rather than those that have so long been accepted in the systems adopted after Loew and which are found so futile for the Australian element.

With the present paper will be found a study of the prothorax of the Dasypogoninae, this structure having a character of tribal importance. It has

enabled me to propose a new tribe which, though defined, is left unnamed pending further information. Following on Hermann, the tribe Laphriini is divided also.

In concluding these remarks, I would express my indebtedness to Professor R. H. Painter who has kindly supplied me with a few North American Asilidae, one genus of which comes well within a new tribe proposed hereunder. Also Mr. E. Jarvis has kindly allowed me to retain for study some described North Queensland Laphriini and Atomosiini that he submitted for determination some years ago. These especially have been valuable towards drawing up a comparative study based upon Hermann's paper of 1912.

On the prothorax of the Dasypogoninae.

In the Brachyrrhopalini, a tribe of undoubted homogeneous nature, the prosternal plate which is placed ventrally and adjacent to the anterior coxae, is distinctly separated from the dorsal portion of the prothorax by a definite membrane that, in some cases, is larger than normally found, and sometimes there are wrinkles in this membrane that indicate its probable flexibility when in the living state. The actual size of the ventral plate is sometimes a little smaller than usual, but invariably the membrane folds beneath its lateral edges.

In the Saropogonini, including *Thereutria* and *Metalaphria*, but excluding *Clinopogon* and *Cryptopogon*, the defined genera have the ventral plate clearly perceptible, but as in the Brachyrrhopalini, there would appear to be gradations with respect to the density of the membrane, some being of a sturdier form than others.

In the Phellini, *Phellus* has the plate amalgamated with the other parts, but ridges mark lines of fusion, so it would appear here as if the membrane had become completely chitinized; on *Psilozona* the membrane is normal.

Finally, in the Laphriini there are no signs whatever of the components of the prothorax, the whole having a smooth surface of uniform chitinous nature; the same applies to the Atomosiini.

A NEW TRIBE.

The two exceptions mentioned above under the Saropogonini, namely *Clinopogon* and *Cryptopogon*, to which must be added the American genus *Neopogon* and possibly others, all have the prothorax similar to the Laphriini type. All disagree with the Laphriini in the nature of the female genital parts, the shape of the head, venation and sundry other characters, whereas they agree in these matters amongst themselves. They will form a new tribe divided from the remainder of the Saropogonini in the nature of the prothorax and in the front. I have not seen *Stichopogon*, so am uncertain if this genus is related.

CRYPTOPOGON White.

White erected this genus for a somewhat Therevid-like Asilid, having an interradial crossvein. It comes near *Clinopogon* and is not easy to distinguish from small specimens of that genus. I have before me an undoubted *Cryptopogon* that is without the interradial crossvein, but compares very favourably in all other respects; the venational character would therefore appear to be specific, not generic, in importance. The characters of the genus would thus be:—

Front very broad at summit, very narrow at antennae, face widens from there (this apparently is a tribal character). Antennae with the fourth segment rather long, about twice as long as broad. Moustache composed of a number of bristles

in a dense mass restricted to an area near the oral margin (White states "confined to" but that term is a little misleading as there is more than one row of bristles). Prothorax of one piece; scutellum without bristles; abdomen of moderate length, parallel-sided. Femora somewhat swollen (apparently another tribal character); tarsi with extra long bristles. Venation with or without an interradial crossvein; all marginal cells open, except the anal which is closed slightly before the margin.

CRYPTOPOGON OBSCURUS, n. sp.

A brownish species with much white tomentum which completely covers the face and forms a pattern on the dorsal area of the thorax. Abdomen black, with white tomentose side spots and more or less interrupted cross bands at base of segments; tomentum also on coxae and traceable on femora. Hair on front and bristles behind ocelli black, elsewhere on head white. On thorax and abdomen the hair is mainly black, but white hair occurs in places. Hair on legs white, bristles there both black and white. Legs mainly black, but basally the tibiae are brownish to a varying extent. Wings hyaline with a strong tendency towards dark infuscations at crossveins. In other respects White's specific description of *C. vernaculus* also applies to the present form, but it is at once distinguished by the lack of the interradial crossvein, the black spots at crossveins and the darker legs.

Length, 7-8 mm.

Hab.—Queensland: Sunnybank, near Brisbane, 2 males and 2 females. November, 1925, 1927 and March, 1928. Occurs in the bush on the ground, but its small size and obscure colouring make it very difficult to detect. *C. vernaculus* also occurs in Queensland, but seems to be confined to more inland districts.

Tribe **Saropogonini.**

CHRYSEUTRIA, n. gen.

Antennae with four segments and a minute apical spine; moustache confined to a row of oral bristles. Thorax with a lateral spine just anterior to the transverse suture as in *Chrysopogon*; prothorax with ventral plate clearly defined; scutellum without bristles. Abdomen rather long and parallel-sided, each segment slightly bulging on the dorsal area; genital spines of the female conspicuous; first segment with an apical lateral spine. Legs with a spur on the anterior femora. Wings with all marginal cells open.

This genus differs from *Chrysopogon* and its allies in the structure of the female genitalia and in the more generalized type of abdomen being parallel-sided and more elongate, whereas on *Chrysopogon* it expands from the base towards the apex. From *Thereutria* and its allies it is distinguished by the presence of the thoracic spine and again in the abdomen, that of *Thereutria* tapering towards the apex. The genus belongs to the Saropogonini.

CHRYSEUTRIA NIGRINUS, n. sp.

Black with white tomentum and hairs. Head of usual shape; the white tomentum runs from the oral margin in two broad lateral stripes, meeting on the area surrounding the base of the antennae. The moustache is formed by an irregular row of about 16 white, more or less parallel bristles. Palpi and antennae with mainly black hairs. The whole area behind the eyes is completely covered with white tomentum and long white hairs are fairly plentiful there, but two pairs of black bristles occur behind the ocelli, arranged in a transverse row. Some white tomentum occurs conspicuously on the prothorax, from the humeral tubercle,

along the lateral suture, and on to the scutellum; also along the transverse suture and as a very faint design on the dorsal area. It also occurs over the larger part of the ventral area. On the abdomen it lies along the transverse marginal sutures and forms up to five pairs of lateral spots, one on each basal segment. Coxae with white hairs and tomentum. Femora very scantily supplied with short hairs and these are sometimes black; long white hairs occur on the ventral area of the anterior pair. A row of scattered black bristles is on the posterior side of the anterior femora, on both sides of the intermediate, and on the anterior side of the posterior femora. Tibiae and tarsi studded with short white depressed hairs and black bristles. Halteres yellow. Wings suffused with black-brown, very heavily so along the veins.

Length, 14-15 mm.

Hab.—Queensland: Sunnybank, near Brisbane. Two females, November, 1927. The holotype was taken flying backwards and forwards from a termite's mound to a spray of tall grass in seed, a distance of about two or three feet, coming to rest at each visit. The paratype was captured about a fortnight later, thirty yards from the same place with an Eumenid wasp as prey; it was skimming an inch or two above the grassy ground, not attempting to rest. These were the only two seen, and it has not been detected in any other collection. It might readily be mistaken for a *Chrysopogon*, but apparently it has not been described under that genus.

Genus Neosaropogon Ricardo.

The type of this genus was fixed in 1921, namely *Dasypogon princeps* Macquart, but recently it has become evident that more than one form might have been placed under the name by Ricardo. In the original definition is recorded "the absence of any style to the third segment of the antennae". Hitherto I had not met with any specimen in Australian collections agreeing in this character, but now I have a pair from Brisbane that misses the fourth segment. On re-examining the material in the Ferguson, the Queensland Museum and the Australian Museum collections, I find a variation in the size of the fourth segment (so called style) and also variations in markings, but judging from the Queensland pair referred to there is a tendency to dimorphism which complicates the study.

Tribes **Laphriini**, and **Atomosiini**, n. trib.

Hermann in 1921 divided certain Asilids into Acanthocneminae, which have a spur on the anterior tibiae, and the Eremocneminae which are without the spur. The latter is again divided into the Atomosiinae and Laphriinae.

It will readily be seen that *Thereutria* and *Metalaphria*, if placed in the subfamily Laphriinae as originally done, would fall into the first of these major divisions, but their affinities are too close to the Saropogonini to permit separation under such an arrangement. Hermann placed four genera in his first division, but I do not know how they compare with the Australian genera.

Judging from the complex hitherto placed in the tribe Laphriini, the Australian forms would contain, under Hermann's group Laphriinae, all the species recognized as being *Laphria*, also *Nusa queenslandi* Ricardo and *Laphria tectamus* Walker. The last of these Bigot placed in the genus *Andrenosoma*, and there can be little doubt such a position is superior to that of *Nusa* where Ricardo placed it. Although having the venation comparable to the last form, *Nusa queenslandi* seems to have more affinities with *Laphria*, and taken as a whole all these, and presumably

Maria, would form the tribe Laphriini as opposed to the remainder, the Atomosiini. To this extent the Australian forms uphold Hermann's groups, but suitable characters for dividing them into tribes have not yet been fully ascertained. As an immediate guide the manner in which the veins M_3 and M_4 coalesce may be used. Under the tribe Atomosiini come *Atomosia*, *Adeolus* and *Cyanonedys*.

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FEATURES OF THE VEGETATIVE ANATOMY OF THE AUSTRALIAN WHITE BEECH (*GMELINA LEICHHARDTII*).

By W. D. Francis, Assistant Government Botanist, Botanic Gardens, Brisbane.

(Plates xxix-xxxi; nine Text-figures.)

[Read 26th September, 1928.]

Introduction.

The Australian White Beech is a large tree. It is a constituent of the luxuriant rain forests of Eastern Australia. In recent years these forests have dwindled rapidly before the penetration of settlement into areas of the continent possessing a bountiful rainfall and fertile soils. Like the majority of the species of the heavy rain forests of eastern and north-eastern Australia the White Beech is allied to Papuan and Malayan types. These Papuan and Malayan types are sharply contrasted with the Australian element of the flora as exemplified by the commoner components of the Eucalyptus and Acacia forests. The genus *Gmelina*, of which the White Beech is a species, is distributed in India, Ceylon, Malaya, South China, the Philippines, Papua and Australia. Three species are found in Australia. The one under discussion, *Gmelina Leichhardtii*, is recorded from as far south as Shoalhaven in New South Wales (35° S.) by J. H. Maiden (1904). The writer has seen it as far north as the Eungella Range in Queensland (21° S.).

Gmelina Leichhardtii is mesophytic in character and in vegetative features possesses little in common with the large section of Australian vegetation which is adapted by xerophytic characteristics to withstand drought, desiccation and the effect of bush fires. The trees in their natural state are now rare, owing to the extent to which the wood has been sought after and the trees felled for commercial timber. In the future the species may be planted extensively in reforesting operations on account of the commercial value of the wood.

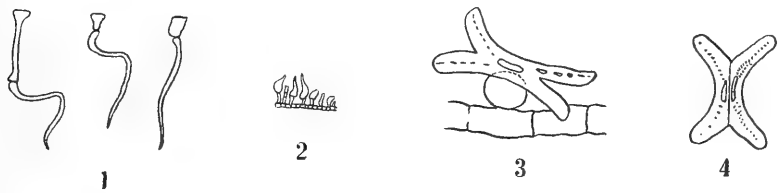
The popularity and economic value of the White Beech are attributable to the qualities of its wood. Although it is neither highly figured nor particularly ornamental, the wood is durable in exposed situations and can be worked with remarkable ease. In view of the extent to which it has been used it seems somewhat remarkable that the timber has not been anatomically described; at least, no microscopical accounts of it have come under the notice of the writer.

In this paper a number of the more important features of the vegetative anatomy of the tree will be outlined. The anatomy of the wood will be described and illustrated as this commodity is an important one from an economic aspect. The microscopical characters thus portrayed will be of value in identifying the wood in critical instances. Features such as the shedding of the bark and the structure and mechanism of the stomata deserve consideration on account of their physiological significance.

Some attention will be given to microchemical subjects. An account of the occurrence and distribution of hesperidin or a hesperidin-like substance and some details of the exact location in the wood of the white deposit known as gmelinol are included. Data of this kind may be of assistance in eventually elucidating the biological functions of these and similar compounds.

The Hairy and Glandular Covering.

The young shoots, young branchlets and petioles are covered by a fine, but dense, brownish pubescence, consisting of short, blunt hairs. Each hair is situated upon an epidermal cell and consists of 1-5 short cells. When there are more cells than one in each hair the cells are superposed and the terminal cell of each hair is often broad and somewhat expanded (Text-fig. 2). The cell walls of the hairs stain red when treated with an alcoholic solution of Sudan III, indicating that they are cutinized or partly cutinized. The upper surface of the leaf is free of hairs, except on the larger nerves which are sometimes very sparsely clothed with the four-limbed glands shown in Text-figs. 3 and 4. In addition, the leaf surface above the larger nerves in some cases was observed to carry occasional short,



Text-figs. 1-4.—*Gmelina Leichhardtii.*
1. Types of hairs on under side of leaf. × 50.—2. Portion of epidermis and hairy covering of branchlet. × 70.—3. Four-limbed gland on vein on upper side of leaf, viewed partly in profile. × 300.—4. Four-limbed gland on under side of leaf, surface view. × 300.

stellate hairs. The under side of the leaf is furnished with comparatively long, soft hairs which are most abundant on the raised nerves and veinlets. They are mostly composed of two or three superposed cells. The basal cell of each hair is often very short, but sometimes it is elongate (Text-fig. 1). The four-limbed glands illustrated in Text-figs. 3 and 4 are fairly frequent on the under side of the leaves. These peculiar glands are attached to the epidermis by a single globose cell. It is not evident whether these glands serve merely a protective purpose or are concerned with physiological processes such as secretion and exchange of gases.

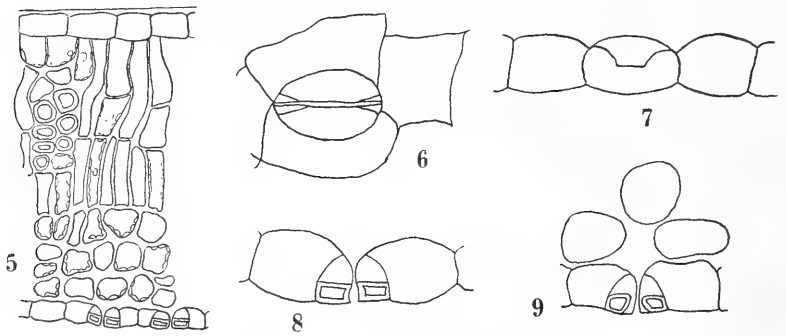
Outline of Anatomical Features of the Branchlet, Stem, Leaf and Root.

Branchlets 3-5 mm. in diameter were examined. The epidermis consists of exceedingly small cells which are faintly shown on the outer side of the periderm in the figure of the lenticel (Plate xxix, fig. 4). The most conspicuous feature of the anatomy of the branchlets is the interrupted ring of sclerenchyma between the cortex and phloem. It consists of thickened and lignified bast fibres which in transverse sections often show as semicircular or crescent-shaped groups. A few lenticels occur on the branchlets. They are pale in colour and spindle-shaped in outline. A transverse section of one of them is shown on Plate xxix, fig. 4.

In the bark of the stem of large trees, the interrupted ring of strongly lignified bast fibres which is characteristic of the branchlets has disappeared with the shedding of the outer bark. Scattered groups of thickened and lignified parenchyma cells are fairly frequent (Plate xxxi, figs. 7, 8, 9). Parenchyma, tangential rows of sieve tubes and rays constitute the other tissue elements of the living bark of large trees (Plate xxxi, figs. 7, 8, 9). The outer dead bark consists of tissue elements of the same categories as those of the inner, living bark. It is separated from the inner, still active bark by a continuous layer of cork-like tissue or periderm. This separating or abscission layer will be considered in more detail subsequently. The sieve tubes are in a collapsed condition even in the living bark some distance inwards from the layer of periderm which defines the inner limit of the dead bark.

Apart from the midrib, nerves and veins, the blade or lamina of the leaf is thin and delicate. The venation is strongly raised on the underside of the leaf and imparts firmness to the entire organ. The photograph on Plate xxxi, fig. 10 shows the great degree to which the midrib projects on the underside and the extent to which the midrib exceeds the non-vascular portion of the leaf in thickness. The midrib contains a ring of several collateral vascular bundles. Each vascular bundle is partly enclosed on the outer side by sclerenchyma or thickened tissue which is crescent-shaped in outline in cross sections.

The structure of the non-vascular portion of the leaf blade is diagrammatically represented by Text-fig. 5. Very thick cuticle is absent from both surfaces. The stomata are confined to the lower surface. The structure of the stomata is



Text-figs. 5-9.—*Gmelina Leichhardtii.*
5. Part of section through lamina of leaf. The thickened cells on the upper left represent a small vascular bundle in section. In some of the cells the chloroplasts are shown as appressed to the cell walls. In a few cells the nuclei are outlined. × 222.—6. Stoma, surface view. × 700.—7. Stoma in longitudinal section. × 700. 8. Stoma, transverse section through middle. × 700.—9. Stoma, transverse section towards end. × 700.

diagrammatically shown in Text-figs. 6, 7, 8, 9. The structure of the stomata will be described and its relationship to the movements involved in opening and closing the aperture will be discussed subsequently. All of the stomata seen were of the type illustrated.

The anatomy of the root presents few prominent features. The sclerenchyma on the inner side of the cortex in secondary roots 3 mm. in diameter is much

less conspicuous and decidedly more discontinuous than that in the branchlets sectioned. The periderm on the outer side of the cortex forms a fairly thick sheath.

The Wood.

The wood of branchlets, secondary roots and large stems was examined. It consists of wood fibres, vessels, wood parenchyma and rays. The wood fibres are septate and bear simple pits which are more frequent on the radial walls. The vessels are single or in rows of 2-6; the rows are mostly arranged radially. The perforations of the lateral walls of the vessels consist of numerous crowded bordered pits. Tyloses are frequent in the vessels. The wood parenchyma is scanty and generally confined to the immediate neighbourhood of the vessels. The rays are several cells in width (Plate xxx, figs. 5, 6). The freshly-cut wood of large trees is pale or yellowish-white in colour. Its economic properties consist principally of its durability, its freedom from insect attack and the facility with which it can be "worked" by tools. It possesses a principle which attacks iron. Nails which are driven into it are corroded in the course of time. The white deposit which sometimes occurs in the vessels and rays of the mature wood will be dealt with in detail subsequently.

In discussing the durability of the wood the tyloses which are frequent in the lumina of the vessels and the septa crossing the lumina of the wood fibres are to be considered. H. P. Brown (1925, p. 51) states: "Tyloses are indicative of durability in wood because they impede the movement of air and moisture. Fungi and insects are the chief enemies of timber and the former require oxygen and suitable temperature for growth; if these are restricted below the optimum, fungal growth is thereby inhibited. Many of the woods which prove to be durable in contact with the soil and make suitable railway sleepers are featured by abundant tyloses". As the septa in wood fibres exercise a similar impeding effect on the movement of air and moisture they may also be structural factors which promote the durability of the wood of *Gmelina Leichhardtii*. The substance gmelinol which is present in the lumina of the vessels, ray cells and sometimes in the lumina of the wood fibres may have a preservative effect on the wood in a chemical way.

The Structure and Mechanism of the Stomata.

Sections cut through the middle of a stoma and transversely to the slit or orifice show on each side of the orifice two horizontal cells, one below the other (Text-fig. 8). The walls of the lower cell are thickened. Sections cut in the same plane but towards the ends of the stoma indicate that the cell which was on the lower side in the sections through the middle of the stoma is placed at the outer side and the cell which in the middle of the stoma is on the upper side projects downwards to the lower and inner side (Text-fig. 9). The superficial view diagrammatically shown in Text-fig. 6 demonstrates the position of the cells at the surface of the leaf. The thickening of the walls observed in the lower cell in the section through the middle of the stoma is also noticeable in the same cell when cut towards the ends of the stoma. The two cells shown as the lower ones in the section through the middle of the stoma may be regarded as the guard cells and the two upper ones as the subsidiary cells.

Von Mohl (quoted by Haberlandt, 1914) experimentally demonstrated that changes of turgor provide most, if not all, of the motive power in the process of opening and closing stomata. Among other important factors Schwendener

(quoted by Haberlandt, 1914, p. 448) showed that the peculiar distribution of thickened and unthickened areas in the walls of guard cells under the influence of turgor variations produces important changes of shape which are often requisite to the opening and closing of the orifice of stomata.

The structure of the stomata of *Gmelina Leichhardtii* suggests that the subsidiary cells perform a very important part in the opening and closing of the orifice. Those parts of the subsidiary cells which project downwards to the surface of the leaf towards the ends of the stomata may be specially active in the movements involved in opening and closing. As the turgor of the subsidiary cells increases, these end portions of the cells may expand, press against each other and force the guard cells apart. In this manner the orifices of the stomata may be opened. That the walls of the guard cells are rigid for a great part of their length can be inferred from their thickening. It is possible, however, that the walls of the guard cells may be not thickened at the extremities of the cells and that the extremities of these cells are subject to turgor variations and cooperate with the subsidiary cells in forcing the guard cells apart in the act of opening the orifice. The subsidiary cells may contribute to the opening of the orifice in another way. As their turgor increases their outer lateral walls may be pressed outwards. In this movement the comparatively rigid guard cells would be carried with the outer lateral walls of the subsidiary cells in a direction away from the orifice.

Comparison of Anatomical Features with those of other Verbenaceae.

The trichomes on the surface of the leaf of *Avicennia nitida* as figured by Solereder (1908) are similar to some of the short hairs on the young branchlets of *Gmelina Leichhardtii* (see Text-fig. 2). The same author (1908, p. 634) also remarks that a composite and continuous sclerenchymatous ring is rarely present in the bark of the Verbenaceae. *Gmelina Leichhardtii* is not an exception in this respect, as the sclerenchymatous ring is interrupted in the bark of the twigs, stem and secondary root. According to a Plate figured by H. P. Brown (1925) the wood of *Gmelina Leichhardtii* resembles that of *Gmelina arborea*, an Indian tree, in possessing septate wood fibres, paratracheal parenchyma and vessels with bordered pits on their lateral walls. The wood of *Gmelina Leichhardtii* resembles that of Indian Teak (*Tectona grandis*) in having septate wood fibres and frequent tyloses in the vessels, but Teak wood is readily distinguished from Australian White Beech by the arrangement of the vessels in interrupted tangential lines in the spring wood, a feature in wood which is often described as ring-porous. E. B. Copeland's figures (1902) of the stoma of *Oxydendrum arboreum* show that its structure is somewhat similar to that of the stoma of *Gmelina Leichhardtii*, but in *Oxydendrum* the guard cells and subsidiary cells are not superposed in the middle of the stoma. From the superficial view the stomata of *Gmelina Leichhardtii* are somewhat similar in appearance to those of the grasses.

The Shedding of the Bark.

The bark of the stem is mostly grey in colour and scaly in appearance. The outermost dead bark is cast off in small, rectangular or irregular pieces. The bark measures about 14 mm. (0·6 in.) in thickness on a tree with a stem diameter of 60 cm. (2 ft.). The inner, live bark is pale yellowish-brown in colour and is strongly contrasted with the outer, dead bark which is very dark grey or almost black internally. The dead bark constitutes one-third to one-fifth

of the total thickness of the bark. When the bark is severed from the stem, the outer, dead bark readily separates from the inner bark.

Microscopic preparations show very distinctly the tissue which separates the living from the non-living bark. The region of division between the two kinds of bark is characterized by the development of a prominent layer of periderm which consists of series of horizontally arranged cells. In the outermost part of the periderm the cells are collapsed and pressed together. In the intermediate portion of the periderm a few rows of the cells have thickened tangential walls. When fresh sections of the bark are treated with an alcoholic solution of Sudan III the walls of the entire layer of periderm are stained red. This staining by Sudan III is an indication of the presence of a fat-like substance in the cell walls. The layer of periderm is impermeable to moisture. Through its property of preventing the transfer of solutions it acts as a separation or abscission layer between the inner and outer bark. In this way the cells of the bark on the outer side of the periderm are cut off from the supply of nutrient solutions and severed from active cooperation with the inner, living and generative tissues and in consequence cease to function as living cells. Drying out or desiccation follows upon the death of the outer bark and is accompanied by contraction and cracking.

The fracturing which results from contraction is the cause of the scaliness of the bark. The absence of elongated tissue elements of a hardened character in the bark of large stems facilitates the transverse fracturing which is a part of the processes involved in producing the scales of the bark. The centrifugal pressure developed in stem growth must be a very potent factor in producing longitudinal fractures or fissures in the dead bark. The scales are detached on the inner side along the layers of periderm. As it is often only the outer part of the dead bark on large stems that is cast off, the scales in such cases are freed along layers of periderm which are situated in the outer part of the dead bark. Layers of periderm are produced periodically in the outer part of the living bark and as each layer is generated the layers formed previously are forced outwards.

The Occurrence and Distribution of Hesperidin.

In the mounted sections of the branchlets conspicuous needle-shaped crystals were observed. These crystals were often arranged in the form of spheres (sphaero-crystals or spherulites), hemispheres, rosettes and paint-brush-like forms. They were yellow or yellowish-brown in colour. Some of the crystal aggregates could be seen in the cells of the pith when sections were freshly cut and mounted on a slide without any medium. From this observation it is concluded that at least some of the crystals probably exist in the plant while it is in the living state. The crystals are insoluble in glacial acetic acid, 50 per cent. hydrochloric acid, concentrated hydrochloric acid, hot and cold water, alcohol, xylol. They are soluble in concentrated sulphuric acid, concentrated nitric acid, 5 per cent. solution of caustic potash and hot glacial acetic acid. H. Molisch (1921) figures similar crystals under the name of hesperidin. The solubility and insolubility of hesperidin in various reagents as outlined by Molisch (1921, p. 183) and Schneider and Zimmerman (1922) correspond fairly closely with the properties of the crystalline substance occurring in the Australian White Beech. It is therefore assumed provisionally that this crystalline substance is hesperidin. Chemical investigation of the substance is necessary for confirmation of this assumption.

The microscopic appearance of the crystal aggregates of hesperidin in the pith of *Gmelina Leichhardtii* is shown in Plate xxix, fig. 3. The crystals were observed, chiefly in mounted preparations, in the cells of the following parts of the branchlet: the pith adjacent to the wood (copious); the vessels of the wood; the phloem and cortex on the inner and outer side of the sclerenchyma groups (fairly abundant); the cambium (less abundant). The crystals were absent from or very scarce in the central portions of the pith. Minute crystals and crystal groups were very abundant in and about the walls of the protoxylem elements (spiral vessels) and the inner vessels of the secondary wood.

In the leaf the crystals were found in the following places: some of the cells of the tissue surrounding the vascular bundles of the midrib, especially on the outer side of the sclerenchyma bands which are situated on the outer side of the vascular bundles; many of the chlorophyll-containing cells of the spongy tissue of the lower side of the lamina; some of the cells of the xylem of the smaller veins. A few crystals were seen in some of the cells of the xylem groups of the vascular bundles in the midrib. The crystals were not seen in the seasoned wood of large trees. Mounted preparations are satisfactory for determining the distribution of the crystalline substance because it is insoluble in the reagents used in preparing the mounted sections.

Hesperidin is a glucoside. According to authorities quoted by F. Czapek (1925) it has been decomposed into hesperetin (or hesperitin), glucose and rhamnose. The same author states that phloroglucin and hesperitic acid have been obtained from hesperitin, that hesperitic acid is identical with m-oxy-p-methoxycinnamic acid and that hesperitic acid yields isovanillin on oxidation. Molisch (1921, pp. 182, 183) states that hesperidin is fairly widely distributed in the Rutaceae, that it also occurs in the Umbelliferae, Labiatae, Scrophulariaceae, Lobeliaceae, Valerianaceae, Lythraceae, Compositae and Papilionaceae.

The hesperidin in the White Beech appears to originate in the spongy tissue towards the under side of the lamina of the leaf. It may be a secondary product of photosynthesis. If it were a primary product one would expect to find it in the palisade cells towards the upper part of the leaf where the photosynthetic activity is presumably greater on account of the more intense illumination. From the lamina of the leaf the hesperidin is apparently transferred to the branchlets through the medium of the vascular system of the leaf. Some of the more minute crystalline aggregates observed in the vessels of the wood of the branchlets possibly represented the compound in course of translocation to other parts of the branchlet or to other parts of the tree.

The distribution of hesperidin is too general to indicate very clearly where it is used. The fact that it contains carbohydrates and an aromatic compound suggests that it may be utilized in the construction of wood. Czapek (1925, 1 Bd., p. 688) states that for a long time aromatic substances have been obtained from wood. The same author (1925, 1 Bd., p. 684) quotes analyses to the effect that the dry substance of various woods consists of 48-56 per cent. of the complex carbohydrate, cellulose.

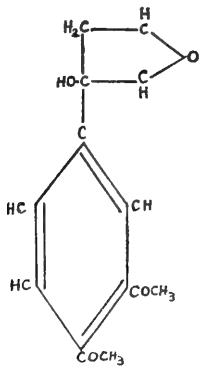
The Location of Gmelinol.

The white substance which is often seen in the vessels and rays of the seasoned wood of large trees has been termed gmelinol by H. G. Smith (1912) who investigated it. According to Smith it is crystalline. In the examples examined by the writer no crystals were seen. The material had a granular appearance

and possibly was in the colloidal state. The wood specimens from which the writer's material was taken might have been exposed to conditions different from those to which Smith's samples were subjected. In this way the different states, crystalline and granular (colloidal ?), which were observed by Smith and the writer, may be accounted for. That the material investigated by Smith and that examined by the writer represent the same chemical substance in different states is evident from the similarity in their behaviour towards reagents. The writer found the white material to be soluble in concentrated sulphuric acid, alcohol, ether, xylol and glacial acetic acid. Concentrated sulphuric acid formed with it a dark red solution. It was insoluble in concentrated hydrochloric acid and 5 per cent. solution of caustic potash.

The material was found to be located in the cells forming the tyloses in the lumina of the vessels, in the lumina of ray cells and sometimes in very minute quantities in the lumina of the septate fibres of the wood. It was not found in the young or living parts of the plant, but was observed only in the seasoned wood of large trees. It is probably present in the walls of the tissue of the seasoned wood in a diffused or adsorbed condition as the tissue of old wood was often coloured deep red throughout when acted upon by concentrated sulphuric acid.

Viewed between crossed Nicols the white substance, when separated from the wood and mounted in water, was seen to be strongly doubly refracting. Smith's measurements of the optical activity of the material are given in his paper. He proposed the following structural formula for gmelinol:



There is evidence to indicate that gmelinol is or may be a product of the partial decomposition of the wood. Smith states that the material collects in the cracks of unsound wood. The inclusion of the substance in the cells of the tyloses in the vessels of the wood also indicates that it is at least a secondary product. An additional reason for regarding it as a secondary product is the fact of its absence from the young, freshly-formed wood.

Smith obtained protocatechuic acid from gmelinol by fusion with potash. Protocatechuic acid together with other substances has been obtained from wood by heating it with caustic alkali according to Czapek (1925, 1 Bd., p. 688). The furfurane, which was considered by Smith to constitute the side chain in gmelinol, may be derived from a pentosane of the wood.

SUMMARY.

The structure of the hairs investing the young shoots, branchlets, petioles and under side of the leaves is described and illustrated. The form of peculiar four-limbed glands, which are most frequent on the under side of the leaves, is also dealt with descriptively and diagrammatically.

The occurrence and discontinuity of a ring of hardened bast fibres in the bark of the branchlets and secondary roots between the phloem and cortex are outlined. Fairly frequent groups of thickened and lignified parenchyma cells are remarked upon as constituting the sclerenchymatous elements of the bark of the stem of large trees. The anatomical characters of the mature wood of large trees are detailed. In discussing the durability of the wood the effect of the tyloses and the septa of the wood elements in impeding the movements of air and water is referred to.

Xerophytic characteristics are lacking in the leaves. The stomata are confined to the lower surface. The structure of the stomata is described and illustrated. It suggests that the subsidiary cells perform a very important part in opening and closing the orifice.

The short, blunt hairs of the young shoots and branchlets, the interrupted sclerenchyma ring in the bark of the branchlets and roots and the anatomical characters of the wood are correlated with similar structures in other representatives of the Family.

The appearance and structure of the bark of the stem are described. The physical means by which the outer dead bark is resolved into scales and shed are outlined.

The results of microchemical investigations of the occurrence and distribution of hesperidin or a hesperidin-like substance in the species and the location in the wood of a white substance termed gmelinol are stated. It is suggested that the hesperidin may be a secondary product of photosynthesis and that it may be used in the construction of wood.

Locative and chemical considerations form the basis of a suggestion that gmelinol, which H. G. Smith investigated chemically, may be a partial decomposition product of the wood.

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EXPLANATION OF PLATES XXIX-XXXI.

The photomicrographs are of sections stained with Heidenhain's iron haematoxylin and safranin. Figs. 1, 4, 5, 6, 7, 8, 9, 10 were photographed with a 16 mm. apochromat (N.A. 0·3). Figs. 2 and 3 were photographed with a 4 mm. apochromat (N.A. 0·95). Compensating and periplanatic oculars of various powers were used in conjunction with the objectives.

Plate xxix.

Gmelina Leichhardtii.

Fig. 1.—Transverse section through branchlet 3 mm. in diam. About one-half of the entire section is shown. The uppermost dark irregular band represents the hairy covering of short blunt hairs; beneath it the lighter band consisting of 3-5 rows of cells is the periderm. Below the periderm is the broad cortex consisting of rounded cells with very dark walls. Below the cortex the pale hemispheric or irregularly shaped areas indicate the position of the interrupted sclerenchyma sheath. The dark band below the sclerenchyma shows the position of the phloem; below it the broad, lighter band is the wood (xylem). The white roundish areas in the wood are vessels in section. Following on the wood and occupying the lowermost part of the picture is the pith or medulla; the dark spots in it represent crystal aggregates of hesperidin. × 60.

Fig. 2.—Part of transverse section of branchlet 3 mm. in diam. The uppermost part of the picture shows part of the cortex extending inwards between two groups of sclerenchyma (bast fibres). The walls of the bast fibres are thickened and light in colour. The dark-walled cells occupying the middle of the picture and extending across it from left to right constitute the phloem; the cells in the upper part of the phloem with cut ends showing as roundish apertures consist of phloem parenchyma and sieve tubes; the cells in the lower part of the phloem which are arranged in series and whose cut ends appear somewhat rectangular constitute the cambium or generative tissue. Below the cambium and occupying the lowermost part of the figure is the wood; it is lighter in colour than the cambium. The two large apertures in the wood towards the right are vessels in section. The dark-walled cells in series in the wood constitute the rays. × 210.

Fig. 3.—Part of transverse section of branchlet 3 mm. in diam. showing part of the pith adjacent to the wood. The crystal aggregates (spherulites, etc.) of hesperidin are seen in many of the cells as dark bodies or granules with dark margins. The dark roundish bodies on the lower right show the indistinct images of spherulites of hesperidin which are out of focus. On the uppermost side of the picture the elements of the wood are indistinctly seen. The smaller cells on the upper left are the spiral vessels of the protoxylem in cross section; they are out of focus and show false doubling of the walls. × 210.

Fig. 4.—Cross section of lenticel of branchlet 3 mm. in diam. The pale tissue is periderm. Above the periderm on each side of the broad opening of the lenticel the small-celled epidermis is indistinctly visible; it has dark walls. Above the epidermis the hairy covering is disposed and is represented as a dark confused mass. To the left of the aperture of the lenticel a short hair is shown in which the junction of two cells is shown; the upper cell has a broad base and rapidly tapers at the apex. The layer of dark cells in the opening of the lenticel has stained deeply with the haematoxylin and resembles in this respect the hairy covering. The phellogenetic cells are shown below the pale mass of periderm cells which are situated towards the middle of the lenticel. The dark tissue in the lowermost segment is the cortex. × 100.

Plate xxx.

Gmelina Leichhardtii.

Fig. 5.—Transverse section of mature wood of large stem. The large apertures represent the vessels in section. Projecting inwards from the walls of the vessels are the tyloses. The elongated cells arranged in long lines from top to bottom of the picture constitute the rays. The meshwork of small, roundish apertures shows the wood fibres in section. × 120.

Fig. 6.—Tangential section of mature wood of large stem. The broad irregular pitted band towards the middle of the picture shows a vessel in longitudinal section. The numerous spots on the vessel walls show the positions of the bordered pits. The two slightly oblique lines crossing the vessel are transverse walls. The irregular lines in the uppermost part of the vessel represent tyloses. A small amount of wood parenchyma is shown on the lowermost left side of the vessel. The lens-shaped areas with honeycomb-like pattern are rays in section. The long, wavy dark lines passing from top to bottom are the walls of the wood fibres. The short lines at right angles to the walls of the wood fibres are the septa which cross the lumina or cavities of the wood fibres. × 120.

Plate xxxi.

Gmelina Leichhardtii.

Fig. 7.—Transverse section through the outer bark at the junction of the living and dead tissue. The light, wavy line across the middle of the picture marks the beginning of the abscission (or separation) periderm layer. Above the white wavy line

is the dead tissue. The tissue extending upwards in the figure for about one inch from the white, wavy line consists of periderm. Above the periderm and occupying the uppermost portion is parenchyma with some sclerenchymatous cells at the upper extremity. Below the white wavy line the regularly seriate cells constitute the phellogenetic tissue from which the periderm originates. Two large groups of sclerenchyma are shown on the lowermost and lower left parts of the picture. × 40.

Fig. 8.—Transverse section of the outer living bark on the inner side of the abscission periderm. From and above the middle, large groups of sclerenchyma occupy the picture; the cells in this kind of tissue are only imperfectly defined in the picture. The irregular perpendicular bands on the lower side are the rays of the phloem. The dark, irregular, horizontal lines represent areas of collapsed sieve tubes. The roundish cells composing the ground tissue constitute the parenchyma. × 40.

Fig. 9.—Longitudinal section through the outer bark at the junction of the living and dead tissue. Shows the same tissues as Fig. 7 but in longitudinal section. The abscission periderm is shown as the broad, perpendicular band towards the left. The dead tissue commences at the light portion of the perpendicular band and extends to the left of it. The dark, irregular, perpendicular lines on the right represent areas of collapsed sieve tubes. The lens-shaped area of large cells on the extreme right constitutes sclerenchyma. Smaller-celled sclerenchyma is shown below and to the right of the centre. On the extreme right above the large sclerenchyma cells portion of a phloem ray is represented by small horizontally arranged cells. × 40.

Fig. 10.—Transverse section through midrib of leaf. Several hairs are shown on the exterior. The dark-walled and thick-walled cells beneath the epidermis (of superficial layer of cells) consist of collenchyma. The principal feature of the internal part of the midrib is the ring of eight collateral vascular bundles. The outer side of each vascular bundle is partly enclosed by sclerenchyma which is not shown in detail. The larger, irregularly seriate cells on the inner side of the vascular bundles constitute the xylem. The very minute dark-walled cells of the outer side of the xylem in each bundle form the phloem. The central part of the midrib is occupied by large-celled parenchyma. The large cells between the vascular bundles and the collenchyma also consist of parenchyma. × 40.

WILLIAM AITCHESON HASWELL.

1854-1925.

(*Memorial Series, No. 1.*)*

(With Portrait.)

One of a large family of an Edinburgh banker, Haswell was born at Gayfield House, Edinburgh, on the 5th August, 1854. While other members of the family showed ability in art and music he, in early life, displayed a preference for quiet reading. His school was the famous Edinburgh Institution, whence he proceeded at a comparatively early age to the University of Edinburgh. Here, at this time, by a happy coincidence, an extraordinary combination of some of the most brilliant teachers of the period found in young Haswell an eager and responsive student, who showed unusual aptitude in these spacious intellectual pastures. After winning high distinction in widely different subjects, he fitly completed a great University career in 1878 by graduating as B.Sc. and by winning the Bell-Baxter Scholarship awarded to the most distinguished Natural Science student of his year. He had already graduated as M.A., and in 1887 he achieved his D.Sc.

His friend and former colleague, Professor J. T. Wilson, writes: "It must be regarded as a fortunate circumstance that Haswell's period of training in Natural Science coincided with Professor Huxley's temporary occupation of the Chair of Natural History in Edinburgh. He thus came under the scientific and personal influence of that great master of animal morphology".

He studied zoology under Wyville Thomson and Huxley; geology under Sir Archibald Geikie, of whose class he was medallist; surgery under Lord Lister.

His earlier intention appears to have been to follow medicine as a profession, but even the greatest of surgeons could not induce any deviation from the path set by him in the later years of his University life, and his love of Natural History drew him irresistibly to a scientific career. "There can be no doubt", says Professor J. P. Hill, "it was the teaching of Wyville Thomson and Huxley that gave Haswell that bent for marine zoology that characterized him throughout his life". A friend and fellow student at Edinburgh was Lord Haldane, with whom he studied Mental Philosophy and Logic, and with whom he used to take long walks.

According to Lord Haldane, Huxley discovered his conspicuous aptitude in zoology and took much notice of his work. Lord Haldane himself describes the Haswell of that period as a man of real mark, very accurate and devoted to study and interested in knowledge in many forms. "These early characteristics were precisely those which, within my knowledge of the writer during a long association, remained throughout as the outstanding and distinctive qualities of a greatly esteemed colleague".

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* The Memorial Series will comprise memorials prepared, from time to time, under the direction of the Council, of distinguished Members of the Society who have died.—Ed.

Professor W. L. McIntosh, of the Marine Laboratory, St. Andrew's, in a recent letter to Mrs. Haswell relates the following: "Professor Haswell when a young graduate in Edinburgh and I happened to meet after a celebrated professor's lecture, and he came to me and said: 'Did you notice that Prof. ——— gave the wrong number of vertebrae to a certain specimen?' He was quite right and from that date his wonderful accuracy and acuteness were characteristic to the end. The same care characterized his drawings."

But all the branches of Natural Science, together with Mental Philosophy and Logic, were not enough to satisfy this avid assimilator of learning. Besides winning seven University medals Haswell also won the prize poem of his year on the subject of the "Death of Livingstone".

Amongst the many letters from his Edinburgh teachers is one from Professor P. G. Tait, who states that Haswell was in "Natural Philosophy" "first, with another, the highest place in a very strong year."

Sir Archibald Geikie also wrote of his geology: "You carried everything before you in my class and, what is more, you earned the affectionate remembrance of your class fellows and teacher. In an excursion I had abundant opportunity of cultivating your personal acquaintance and I was led to form the highest opinion of your attainments."

Professor Sir J. Wyville Thomson wrote: "I have the great pleasure in recommending my friend and former pupil, Mr. Haswell, for any appointment connected with Natural Science. Mr. Haswell is an excellent Naturalist, both theoretical and practical and an accomplished and thoroughly reliable gentleman."

Typically characteristic of the adult Professor was the reticent attitude of this modest young prize winner. Only through public notices or through friends did his own family hear of these successes, for he himself would never speak of them. During his longer vacations he found time to travel to some extent through Europe, and to study in Germany. He apparently missed the summer term of 1877 to attend a course in zoology, anatomy, petrography and histology at Leipzig University, a certificate of which is amongst his papers. Once also he went to America. But with a not over-strong physique the strain of this work was telling on him, and, by way of recuperating his health after taking his degree in 1878, he sailed for Australia.

Here he was almost at once welcomed by Sir William Macleay—always on the look out for men through whom, or means by which, he could advance his beloved Natural History. Just as eagerly did the young zoologist respond—scarcely seeming to understand the word holiday or only interpreting it in a way commonly found with men of great mental activity, as change of occupation. Huxley, during his memorable voyage in "the *Rattlesnake*" spoke of Port Jackson as affording an ideal and prolific region for the marine biologist. It is certain that Haswell must have had this in his mind at this period. At any rate with Sir William Macleay's help and encouragement a small marine zoological laboratory was established in a hut at Watson's Bay, and here Haswell initiated that long series of researches that only came to an end with life itself. The collections resulting from the "Chevert" Expedition to New Guinea were being examined and Haswell took a willing share in working on this material. Thus, too, came about the beginning of a long association with this Society, his first contribution being "A description of six new species of Annelids". This paper was read on 25th November, 1878, but his actual presence at the meeting is not recorded. Nor is there any record of any official employment until his appointment as Curator

W. A. Haswell.

of the Brisbane Museum in December, 1879, but during the previous twelve months he contributed no less than nine papers to the PROCEEDINGS of this Society besides two to the *Annals and Magazine of Natural History*, chiefly on widely different branches of marine zoology.

Professor Hill writes of this period: "Young and enthusiastic, Haswell threw himself with great energy into the study of the rich marine fauna of Port Jackson and the adjacent coasts, and in the course of a few years published in the Proceedings of the Linnean Society of N.S.W., numerous papers, mainly of a systematic character, on the Crustacea, Annelida and Bryozoa of the Australian seas. In particular we owe to him the first description of the giant *Phoronis* that occurs in Port Jackson and which he named *Ph. australis* in 1882. Later in the same year he exhibited drawings of the early stages of its development to the Linnean Society. During this period, however, he by no means confined himself to the systematic Zoology of the Invertebrata, but contributed papers of value to the Linnean Society on such diverse subjects as the anatomy of birds, the structure of the paired fins of Ceratodus, the skeleton of Elasmobranch fishes, and the early stages in the development of the Emu. In 1886 he described in the *Quarterly Journal of Microscopical Science* the remarkable striate muscle fibres in the wall of the "gizzard" of *Syllis*, and in 1889 he published the results of a comparative study of the same fibres, in the course of which he described certain remarkable relations between the nerve cells related to them which were of very great interest from the point of view of the neurone theory, and which well deserve reinvestigation. In 1888, also in the *Quarterly Journal of Microscopical Science*, he gave the first detailed account of the anatomy of that interesting ectoparasitic Trematode, *Temnocephala*, a form which will always be associated with his name."

Professor Wilson adds similar testimony "of the scope of his investigations and the catholicity of his interest in the animal kingdom."

Haswell was present as a visitor at the January meeting, 1879, of this Society and was elected a member on April 30th of that year. From January to November of the following year he was at the Brisbane Museum, from which he resigned under the strong inducement to carry out work nearer to his heart.

At the annual meeting of the Linnean Society of New South Wales, 27th January, 1881, Haswell was elected a member of the Council of the Society, on which he served with the greatest regularity till his death. In this year, following the example of Darwin, Huxley, Hooker and Murray in their zeal for first hand knowledge by travel, and metaphorically following the wake of "H.M.S. *Rattlesnake*", Haswell seized on the opportunity afforded by the invitation to join "H.M.S. *Alert*" on a surveying cruise to the Great Barrier Reef. It is regrettable that Haswell himself recorded so little of the incidents of the voyage, but, always a good sailor, he must have revelled in this occasion to study—all too briefly—this illimitable wonderland of marine life. In "Four years in Patagonian, Polynesian and Muscarene Waters, 1878-1882", by R. W. Coppinger, Staff-Surgeon, R.N., C.M.Z.S., p. 180, this reference occurs: "On leaving Sydney we received a welcome addition to our number in the person of Mr. W. A. Haswell, a professional zoologist, residing at Sydney, who expressed a wish to accompany me as far as Torres Strait in order that he might have the opportunity of studying the Crustacean fauna of the east coast of Australia. He was consequently enrolled as an honorary member of our mess, and Captain Maclair kindly accommodated him with a sleeping place in his cabin. I am indebted to Mr. Haswell for much valuable information concerning the marine zoology of Australia."

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On his return he carried out an engagement to Sir William Macleay—who thus showed his thorough appreciation of the brilliant young naturalist—by giving a series of twenty lectures on Zoology at the Garden Palace under the auspices of the Linnean Society of New South Wales.

In 1882 he was appointed Demonstrator in Comparative Anatomy, Physiology and Histology in the University of Sydney; the title being changed in November, 1884, to Lecturer in Zoology and Comparative Anatomy and Demonstrator in Histology. Always interested in the Australian Museum he published that year a valuable Catalogue of the Australian Stalk- and Sessile-eyed Crustacea and. during the absence of Dr. E. P. Ramsay from March, 1883, to February, 1884, he was Acting-Curator of that Institution. On the 3rd February, 1891, he was elected a member of the Board of Trustees of this Museum, in which capacity he gave his valuable services until his resignation in December, 1923.

"Such was the reputation Haswell had established for himself as an original investigator and teacher that the Senate of the University, when the Challis Professorship of Biology was instituted in 1889, offered him the Chair, and this he held continuously until his retirement in 1917" (J. P. Hill). The title was, however, altered to that of Professor of Zoology in 1914, on the appointment of a Professor of Botany. On his retirement the Senate of the University conferred on him the honoured title of Professor Emeritus. During his tenure of the Chair, he three times obtained leave of absence from the University of Sydney for the purpose of visiting many European Universities as well as those of England, Scotland and Wales.

In 1891 the Australasian Association for the Advancement of Science held its biennial meeting at Christchurch, New Zealand. Haswell was President of the Biological Section and thus came into intimate contact with Professor T. Jeffery Parker with whom he formed a close friendship, leading to their joint authorship of the famous Text-book. Of importance, too, was the meeting which followed with a gifted young pupil of Professor Parker, Josephine Gordon Rich, co-author with her teacher of a paper on the Myology of *Palinurus*. Miss Rich was a cousin of his friend, Lord Haldane. Quite naturally Haswell became the guest, then and during following visits to New Zealand, of her father, W. Gordon Rich, at his beautiful home, Toi-Toi. Just as naturally, too, this friendship, commenced through, cemented by, and continued in congenial tastes, led in 1894 to the happiest of marriages and real life mateship, for Mrs. Haswell to the end took the keenest and most sympathetic interest in the work of her husband, generally accompanying him on his expeditions and on his two forms of relaxation, trout-fishing and golf. Mrs. Haswell also contributed a valuable share to the drawings of the Text-book of Zoology.

Not the least of Haswell's legacies to the University of Sydney was the Zoological Museum founded by him and continually developed throughout his career as a valuable supplement to the oral and written work of his teaching. Many visiting teachers from German and other Universities have paid tribute to the high standard and value of this Museum.

"Outside the ranks of professional zoologists Haswell is perhaps best known to the scientific world as the joint author, with his staunch friend the late Professor T. Jeffery Parker, of the monumental Text-book of Zoology", now (1928) in its 4th Edition, "which was first published in 1898 after several years of unremitting toil on the part of the authors" (J. P. Hill). This has become the standard text-book in the English language; and it is used extensively and highly appreciated in America as well as throughout the British Empire. Owing

to Professor Parker's death shortly after the publication of the original edition, the second (1910) and the third (1921) editions were entirely prepared by Haswell; as was also the abridged "Manual of Zoology" first published in 1899 and reprinted in 1908, 1913 and 1918. The fourth edition of the Text-book was issued in 1928. This contains 1,536 pages in two volumes, and includes valuable supplements on Distribution (23 pp.), Philosophy of Zoology (24 pp.), and History of Zoology (22 pp.).

"The Text-book is a monument of scholarship and is apt to disconcert the unwary student who, deceived by the ease of its English, fails to realize the compression of its matter throughout." (R. H. Cambage).

The late Professor Launcelot Harrison wrote in 1926 of this work: "It has maintained its pre-eminence for nearly thirty years. To the zoological confraternity in the United States the University of Sydney was known as Haswell's University." Then in discussing the future of Zoology he wrote: "The trend of Zoology is changing. The experimental method, still in its infancy, is making rapid strides and its results are so important that they, together with recent advances in physiology, must largely replace the pure morphology of current text-books. But 'Parker and Haswell' will always hold its place as an Encyclopaedia of Morphology and Comparative Anatomy to which the zoologist must refer, just as he still refers to the ancient Owen's 'Comparative Anatomy of Vertebrates' for facts which are not otherwise easily accessible." The wide use and appreciation of the "Text-book of Zoology" is further indicated by its translation into Russian by M. A. Menstier (Moskva, 1908). A characteristic act of self-denial and chivalry towards his late co-partner in authorship occurred in connection with the publication of the "Manual of Zoology" and explained in Professor Haswell's own preface to that work as follows: "Owing to the lamented death of Professor T. Jeffery Parker, at a time when but little progress had been made with this work, his actual share in it has been but slight: but the general plan of the work was arranged between us, and the earlier parts had the advantage of his revision, and more especially as this smaller manual owes a great deal to his work in the "Text-book", it has been thought right to let the present work appear under our joint names as originally intended." By this chivalrous act Haswell received a considerably curtailed income from the proceeds.

The Linnean Society of New South Wales will always hold Professor Haswell in grateful memory. He was its President for the years 1891-1893, and his Presidential Address was memorable for his suggestion of the Macleay Memorial Volume, a suggestion at once adopted, and followed up by its publication in 1893, and to which he himself contributed. He was the intimate friend of Sir William Macleay during the later years of Sir William's life and—next to the late J. J. Fletcher—was probably closest in touch with him in discussing his ideas of endowments. Haswell also contributed to the welfare of this Society by a service of forty-three years on its Council and by a continuous series of papers published in its Proceedings. As stated above, his first paper "On six new species of Annelids" was read in November, 1878, his last, "Critical notes on the Temnocephaloidea" in November, 1924, only two months before his death. During these forty-six years he contributed no less than seventy-four papers, in addition to one in collaboration with Professor J. P. Hill. These include for their subject matter, almost every group in the animal kingdom and even one botanical paper, "Notes on *Tmesipteris* and *Psilotum*". He also wrote several papers that were read at the several biennial meetings of the Australasian Association for the Advancement of Science and published in their Reports, and

one, at least, "On the question of the occurrence of living organisms in the Artesian Waters" in the *Journal and Proceedings of the Royal Society of New South Wales.*

On the occasion of the visit to Australia of the British Association for the Advancement of Science in 1914 he contributed to the Federal and the New South Wales Hand-books, editing the Zoological Sections of the latter. During his last few years, in addition to his own research work he edited the reports of the Australasian Antarctic Expedition, issued by the Government Printer at Sydney. Outside Australia Haswell contributed widely to British and European scientific journals. These include the *Annals and Magazine of Natural History*, the *Quarterly Journal of Microscopical Science*, the *Transactions of the Linnean Society of London*, the *Zoologische Anzeiger* and others.

The Crustacea and the Polychaete Annelids constituted his chief systematic interest and he returned to the latter group after his retirement from the Challis Chair, publishing two papers on Syllids in 1920. But his papers deal with almost every Phylum, from the Protozoa (parasitic Euglenoids and colonial Radiolaria) to the Mammalia (brain of Gray's whale). The paired fins of *Ceratodus*, the myology of pigeons, the embryology of the emu, attracted his attention amongst the vertebrates, but there is no doubt that he was primarily an invertebrate zoologist, and that of the invertebrates the Platyhelminths held most interest for him. He wrote a number of papers on the Turbellaria, Trematoda and Cestoda. Possibly arising out of his early interest in Crustacea, he made a special study of the Temnocephaloidea, parasitic upon the Australian freshwater crayfishes. He monographed the group in the Macleay Memorial Volume (1893), studied its embryology, after overcoming very great technical difficulties (*Quart. J. Micr. Sci.*, 1909) and was, at the time of his death, engaged upon its revision. He discovered and described two of the five known species of Histriobdellids, for which he proposed a genus *Stratiodrilus*, and here again he included in his research a study of the embryology.

Professor Haswell invariably collected the material for his own researches in the first instance, although he might invite distant colleagues to gather material for comparison. He did all his own technical preparation, never seeking any help from his staff and, with few exceptions, made his own drawings. Up to the time of his retirement from the University his working day, after the morning lecture, or lectures, was spent immured in his private laboratory. His industry continued to the end, and he was working on a detailed study of the eyes of *Temnocephala* up to the time of his fatal seizure.

He was elected a Fellow of the Royal Society in 1897 and was also a member of various other learned Societies in Great Britain and other countries. In 1915 he was awarded the Clarke Medal by the Royal Society of New South Wales. Outside Australia, then, Haswell was best known as the author of the Text-book and for his numerous and valuable researches. But throughout Australia his name will live long as an inspiring teacher of a second generation of zoologists. On this subject the words of his own student pupils are fitting. The late Professor Launcelot Harrison wrote in his "appreciation": "I first attended his lectures in 1911 as a somewhat elderly undergraduate. My first impression of him remains that of a little man with invulnerable dignity, a nervous manner, and a difficult utterance, which to some extent marred the scholarship of his lectures. For these were scholarly. He was a master of the English language, and although he lectured almost entirely without notes, I never caught him tripping over the composition of even complicated sentences. Apart from lectures we students saw little of him. He never came into the

laboratories in my time, and all practical work was left to his junior staff. As a senior student, however, it was my occasional privilege to take in to him some of the more exciting of my mild discoveries in the field, and at these times his punctilious courtesy and kindliness of manner, as well as the keen interest with which he discussed the material I brought, gave me an insight into the real character of the man. I was to learn all this much better, however, at a later date, when, under painful circumstances, I found myself in charge of the department over which he had so recently presided. I knew him so little that I felt he would be as appalled as I was at my temerity in attempting to occupy his vacated place. But I found him all kindliness and sympathy, and he seemed to be confident that graduates of his training should be able to hold any place. Moreover, he treated me as a colleague on an equal footing, which was as precious in some ways as it was embarrassing in others.

"The younger Haswell I never knew. One story arises out of the past which goes to show that under that reserved Scotch exterior there lay a certain subtlety of humour. The professor's room in the old Zoology Department looked out upon a courtyard in which, one fine morning, Haswell observed two of his students dressing a dog in fine raiment, for the purpose of bringing it into lecture. It duly appeared and, much to the surprise of the originators of the enterprise, Haswell called upon them by name and fined each of them a pound. A third student, who considered himself a bright lad, suggested to the crestfallen conspirators a method by which the fines might be halved. He would go to the professor and confess to having been the sole author of the outrage. He would be fined a pound, the others being let off and they could then each pay ten shillings. All went according to plan up to a point. The student confessed and was fined a pound. He then asked what of the others. The reply came: 'I have already fined them a pound. Good morning! Mr. So-and-So'."

Perhaps the best estimate of the worth and work of a University Professor may be drawn from the positions occupied by the men he has trained. Two of Haswell's graduates have successively occupied his own Chair at the University of Sydney, while others fill chairs in the Universities of Queensland, Tasmania and Adelaide. In addition, Professor J. P. Hill, of University College, London, received most of his training under Haswell at Sydney. Of what other professor in any Australasian University can so much be said?

To this list may be added the names of Dr. R. J. Tillyard, F.R.S., who always spoke warmly of his great debt to Haswell's teaching and help, and Dr. H. L. Kesteven, D.Sc., M.D. The latter writes: "I had always the greatest admiration and respect for Professor Haswell. He was a man of few words and did not encourage his students to seek his assistance. On the other hand, once one had succeeded in getting beyond his reserve, and I believe that this could only be achieved by proving one's earnestness in research and need of his aid, one was more than rewarded. Throughout the years of my studentship I saw little of the Professor. After graduating, however, I took my problems to him and discovered a keen, inspiring teacher and colleague. All the old reserve had gone. He analysed my evidence with me, weighing point by point, suggested further lines of investigation and encouraged me to continue. Professor Haswell was a poor conversationalist, unless really interested in his subject; he had no small talk, but I was always struck by the clarity and appositeness of his remarks when once he did get under way. I do not think that I have ever listened to anyone whose voice and words conveyed so much in so few words. I have still on my shelves a complete transcript of his lectures on the anatomy

and development of the vertebrata as nearly in his own words as it was possible to get them down in long hand. That transcript might be sent to the printer without any editing; and the Professor lectured from brief headings on a single little card.

"Only once do I remember to have seen Professor Haswell unbend completely. We were on a deep sea dredging trip off the entrance to Port Jackson. Twenty miles out, with over a thousand fathoms of line down, we were struck by a Southerly Buster. For a while the excitement ran high. Would we have to cut the dredge adrift, or could the skipper hold the boat against it whilst we hauled in? Everyone on board except the Professor was suffering badly from mal-de-mer but he appeared to be absolutely in his element. The scientific members of the expedition were Hedley, Haswell, Hill, McCulloch and myself and the Professor was the life of the party."

Professor J. T. Wilson writes: "As a University Teacher Haswell's work was marked by the same accuracy and thoroughness which characterized all his efforts. Although somewhat cold and undemonstrative as a lecturer, he was perfectly lucid and logical in statement. In the entire absence of all oratorical emphasis he succeeded in inspiring the serious student with something of his own enthusiasm, and thus in establishing a school of zoology which has provided the occupants of various zoological chairs and lectureships. Nor was his influence as a zoologist confined to the classroom and laboratory. As Councillor and some time President of the Linnean Society of N.S.W., as a member of the board of management of the Australian Museum, and in various other local scientific capacities Haswell exerted a potent influence for the furtherance of zoological interests in the community. On the various University Boards he was a trusted adviser, sparing of speech, but candid and just and fearless in his opinions.

"Underneath his somewhat reticent and shy demeanour Haswell concealed a most genial and kindly disposition. Those who had the privilege of some degree of intimacy with him could not fail to appreciate and admire the fineness of character and the breadth of culture, literary and artistic as well as scientific, which were essential elements in the composition of his calm and unobtrusive personality."

Another colleague says of Haswell: "Beyond his own particular branches of study he had a knowledge and appreciation of literature and philosophy that, when his initial shyness was overcome, made him a profitable companion to those in other walks: and mere acquaintances could not but be struck by his sterling honesty and worth."

His chief recreations were trout-fishing, gardening and golf. An expert fly fisher—perhaps the only sport of his younger days—he used regularly to visit the South Island of New Zealand during the summer recess to indulge his favourite pastime. He played golf and derived great pleasure from tending his garden at Woollahra Point, overlooking a beautiful part of Sydney Harbour. Indeed his knowledge of both theoretical and practical horticulture was unusually wide and he was always greatly interested in the artistic as well as in the productive possibilities of his grounds. Of course botany was a part of his biological equipment, but far beyond the academic regions of the subject he had the familiar intimacy with the minutiae of the native flora only acquired by the natural naturalist, aided by a tenacious memory. In his younger days he was fond of long walks, but about 1900 he was one of the earlier Sydney patrons of the

motor car which he used for his daily journey to the University; and the memory of which the writer cherishes as his own first experience of motor carriage.

Professor Haswell leaves a wife and an only daughter to mourn his loss.

To us, late fellow members with him—and others—he leaves a precious record

of *diligence*—in his accomplished tasks,
of *bravery*—in facing their magnitude,
of *modesty*—in his quiet reticence,
of *sincerity and honesty*—in his fearless following of what seemed to him highest and best.

Haswell represents to us the embodiment of that wide culture that was the result of the combination of the study of Arts and Science in his ancient University, interwoven with the fibres of a character inherited from a fine race—a culture that in the words of Huxley "implies the possession of an ideal, and the habit of critically estimating the values of things by comparison with a theoretic standard."

He takes his last rest in the Waverley Cemetery, within view of, and almost on the shores of that great Pacific Ocean whose mysteries he loved to explore, and from which he interpreted so many things previously hidden. Like Newton he was content to wander along the strand of life, here and there picking up a stray shell of truth from the myriads that lay around him

"Nor paused till in the westering sun
To sing because his task was done."

Other obituary notices utilized and largely embodied above are:—

Prof. J. P. Hill—Obituary Notice of W. A. Haswell (with portrait) in *Proc. Roy. Soc. Lond.*, 1925.

Prof. J. T. Wilson—Obituary Notice in *Proc. Linn. Soc. Lond.*, 1924-25.

R. H. Cambage—Presidential Address, Proc. Linn. Soc. N.S.W., l, 1925, Pt. 1 (April, 1925).

Prof. L. Harrison—"An Appreciation" ("Sydney Morning Herald", February 9, 1925).

H.J.C.

LIST OF PAPERS BY W. A. HASWELL.

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Notes on the Anatomy of Birds. ii. The Lumbar and Sacral Plexuses of Nerves. iii. The Myological Characters of the Columbidae. Proc. Linn. Soc. N.S.W., iv, 1879, 303.

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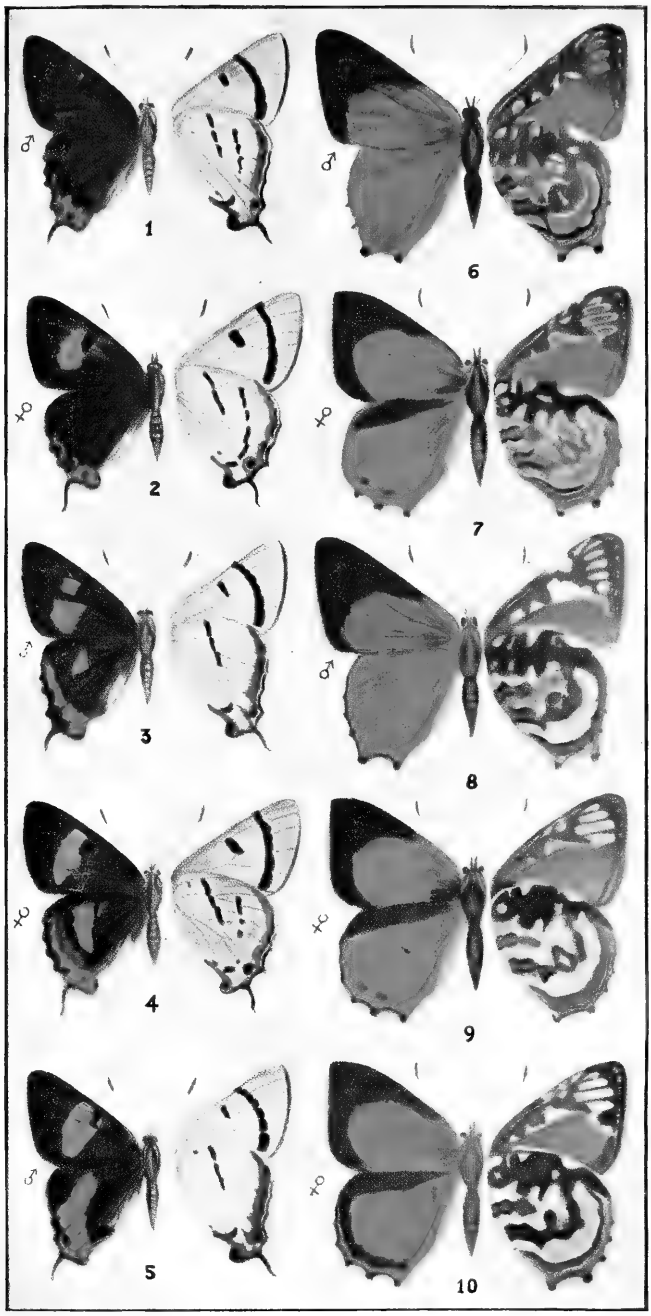
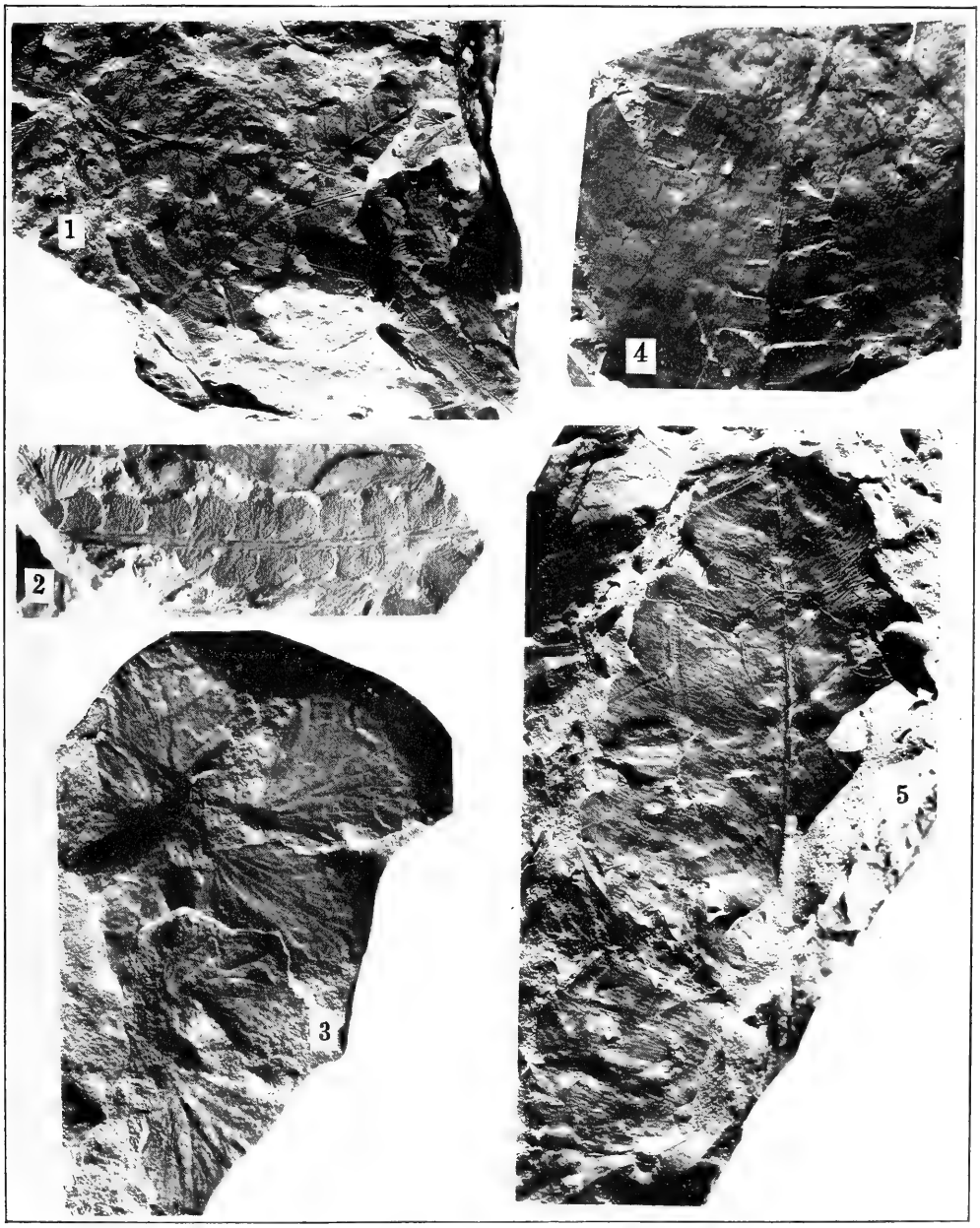
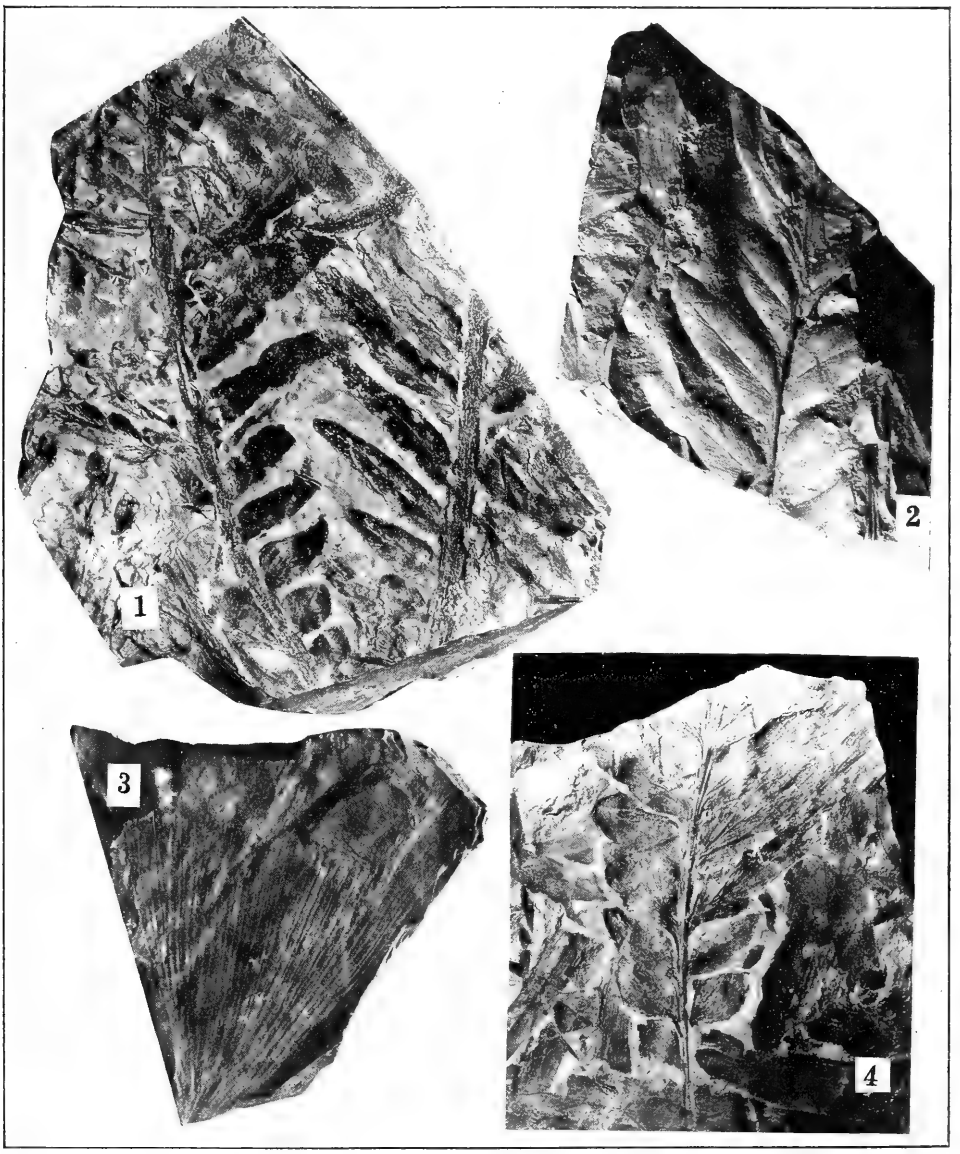


1-4. *Pseudalmenus chlorinda chlorinda*; 5. *P. chlorinda barringtonensis*; 6-7. *Miletus apollo phoebus*; 8-10. *M. apollo apollo*. 1-5, 6, 8 nat. size; 7, 9, 10 × $\frac{9}{10}$.



Fossil Plants from Esk District, Q.



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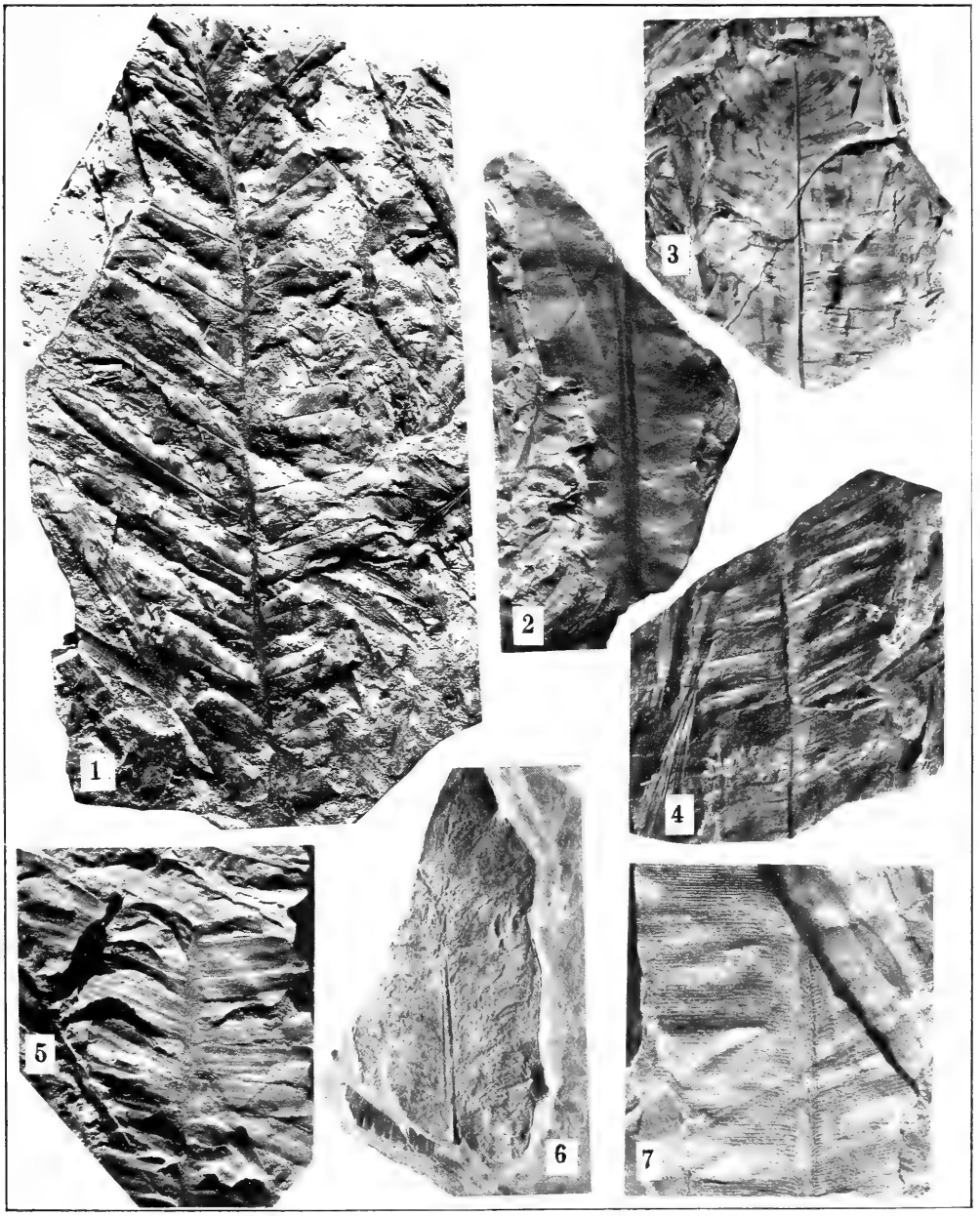

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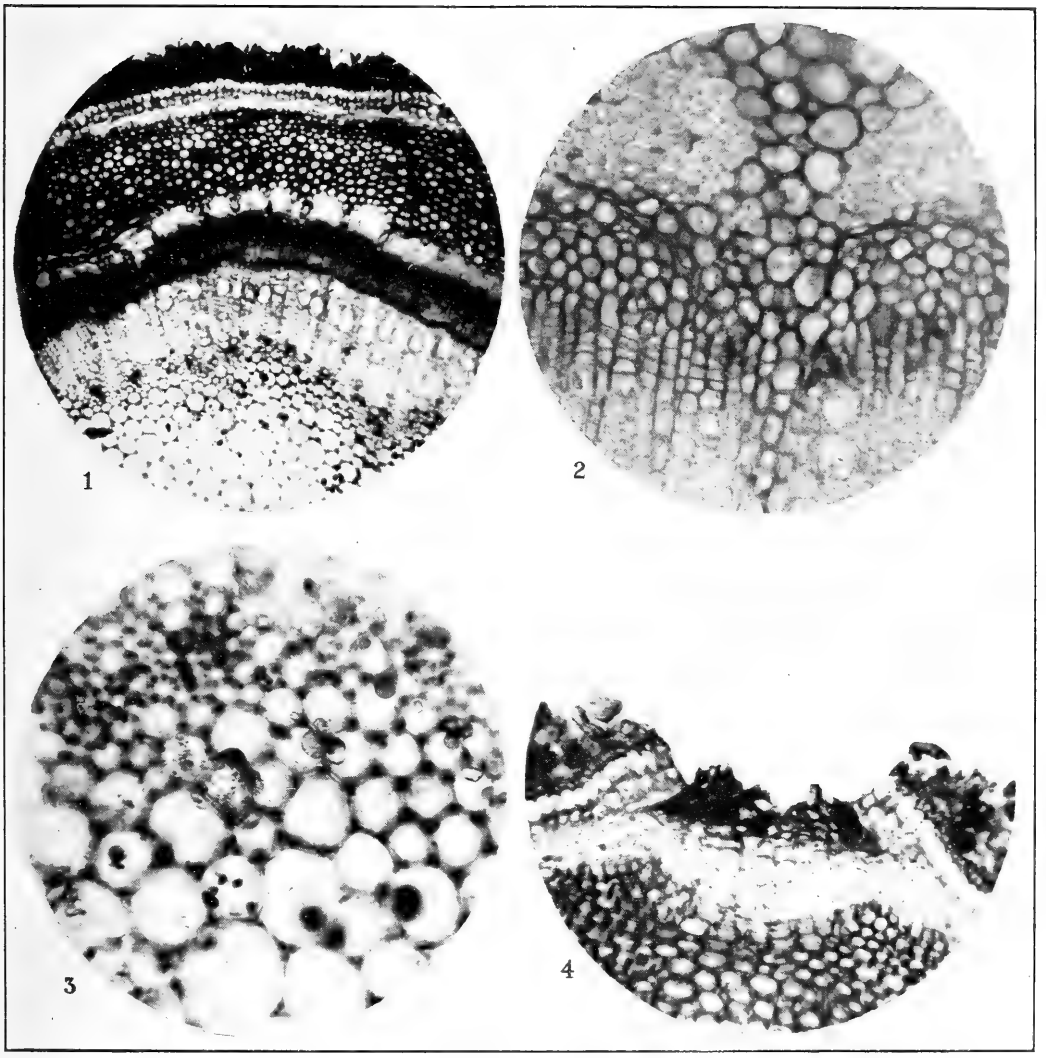
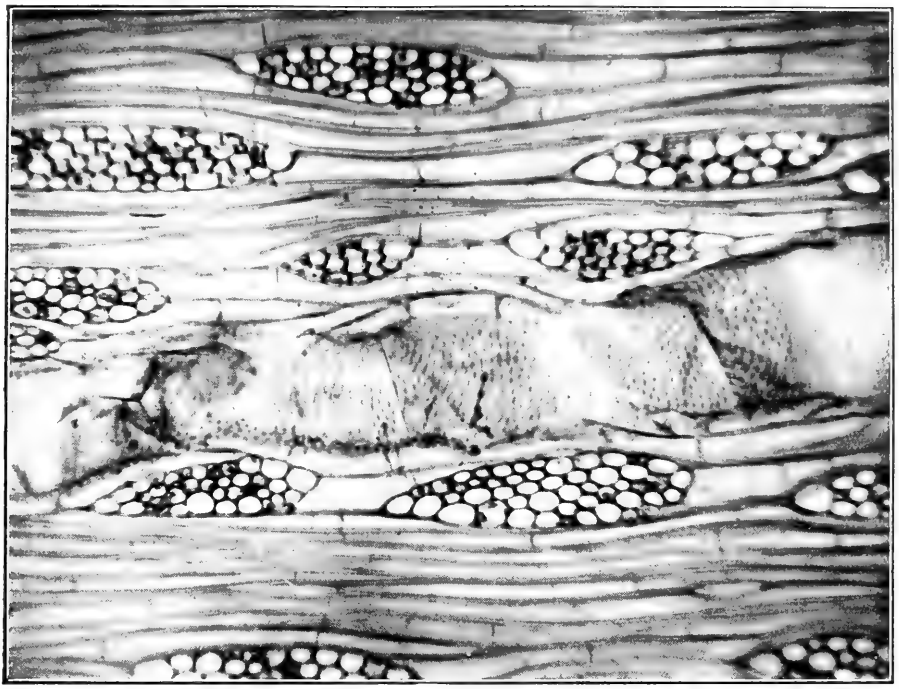


Gmelina Leichhardtii.
1-3, Branchlet; 4, Lenticel.



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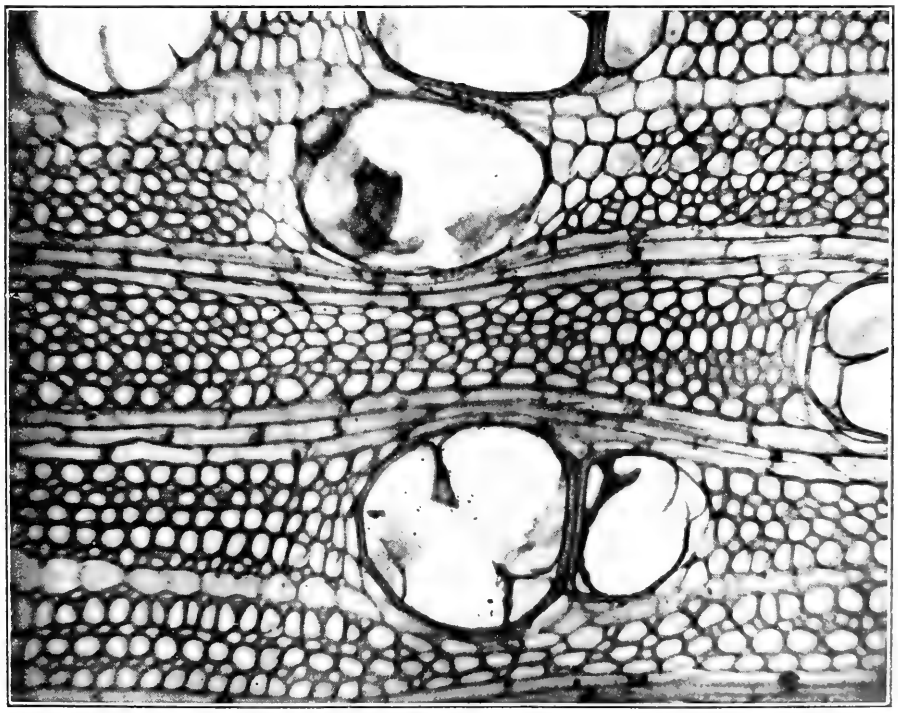

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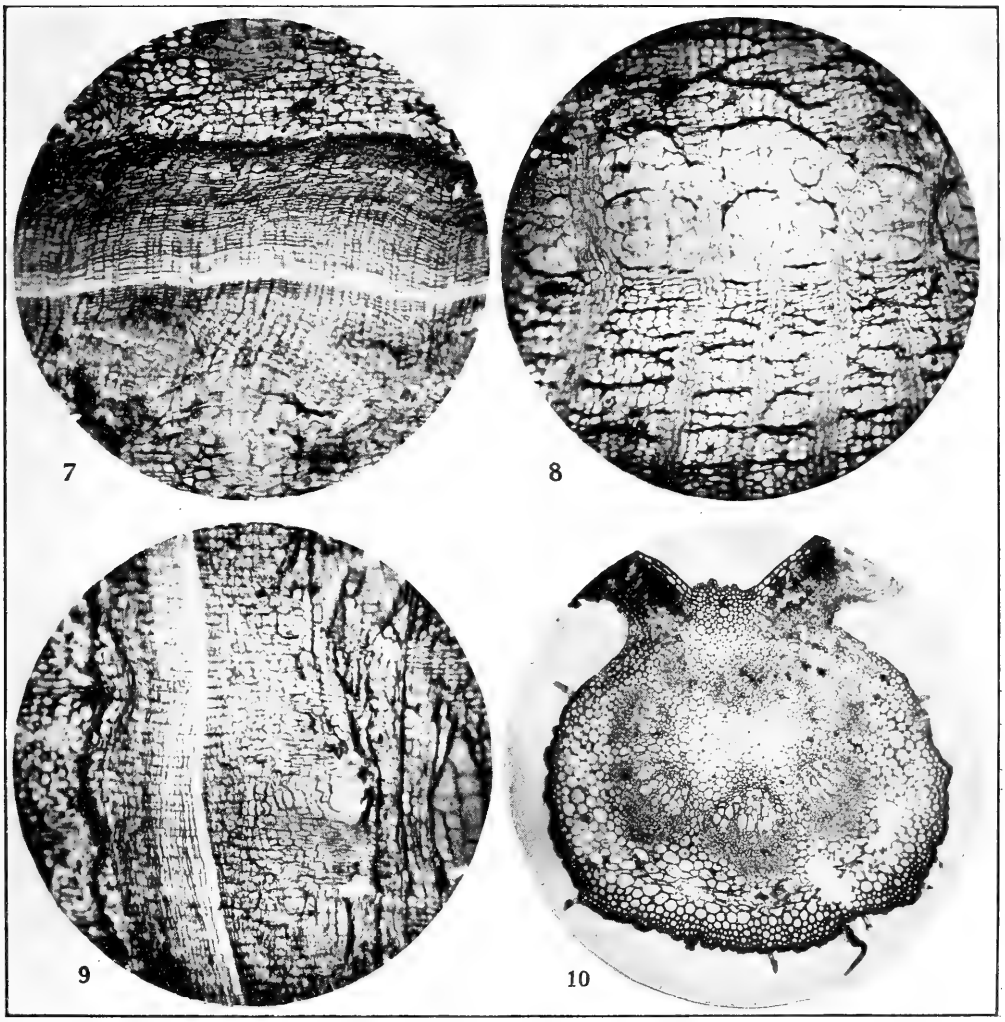
Goetzina Leichhardtii. Wood.



Gmelina Leichhardtii.
7-9, Bark; 10, Midrib.

BOTANY

THE LIFE HISTORY OF *DORYANTHES EXCELSA*.

Part I. Some Ecological and Vegetative Features and Spore Production.

By I. V. Newman, M.Sc., Science Research Scholar in Botany, University of Sydney.

(*From the Botanical Laboratories, University of Sydney.*)

(Plates xxxii-xxxv, and forty-three Text-figures.)

[Read 31st October, 1928.]

Contents.

Introduction.
Occurrence.
Habit.
Floral Organogeny.
Sporangial Structures.
Sporogenesis.
Chronology and Synchronology.
Conclusions.
Summary.

Introduction.

Doryanthes excelsa was discovered by George Bass who took the first specimens to Europe in 1799. Governor Hunter also took to England specimens preserved in spirit. From these and "a single flower which came to perfection at Kew, from a portion of stem without roots, which had been cut many months before in New Holland" (Correa de Serra, 1802, p. 211), the first description was given by Joseph Correa de Serra (1802).

Engler and Prantl (1889, p. 102) place the genus *Doryanthes* in the Agavoideae group of the Amaryllidaceae. The next related genus is *Beschorneria*, then *Fourcroya* and *Agave*, comprising the one section of the group; *Bravoa* and *Polianthes* comprise the other section. Rendle (1904, pp. 307-9) concurs with this arrangement. The genus *Doryanthes* has the following species: *excelsa*, *Palmeri*, *Larkini*, *Guilfoylei*.

The present communication deals with some general ecological features, floral development and spore production. The cytology of sporogenesis is not studied in detail.

OCCURRENCE.

DISTRIBUTION.

The genus *Doryanthes* is found only in Australia, and the species *excelsa* is confined to New South Wales and Queensland. According to Moore (1893, p. 413), *D. excelsa* is found in the Coast District from Jervis Bay (N.S.W.) into Queensland. I have observed it in quantity from Wollongong to Sydney on the Hawkes-

bury Sandstone within some twelve miles from the coast. A curious feature of its distribution is its notable absence immediately north of Port Jackson on that same geological horizon. The distribution appears to be governed chiefly by edaphic factors, and proximity to the sea.

HABITAT.

Influence on Local Distribution.

The plant grows profusely in the sandstone gullies facing south and east, where it forms a definite substratum in the open *Eucalyptus* forest. Plate xxxii, fig. 2 shows the clumps of sword-like leaves (see also Plate xxxii, fig. 1) growing profusely in this situation. The boundary of the community is often very sharp where the ground begins to slope more steeply into these gullies. Where there is iron and clay present in the sandstone, the plant is found on the ridge and northern slopes.

Influence on Flowering and Growth.

The photograph shown in Plate xxxii, fig. 2, was taken in the flowering season, yet there are no flowering stems visible. In the railway clearing at Waterfall flowering was plentiful at that time (*cf.* Plate xxxii, fig. 1). There has been flowering every year from 1924 to 1928 inclusive in the clearing; but in the gully shown in Plate xxxii, fig. 2 there was flowering in 1924 and 1928 only, and very little even then. Moreover, the plants in the shady situations are not nearly such thick clumps; nor have they such large leaves as the plants in the clearing, which are very sturdy indeed. The sturdiness may be due to the greater light in the clearing; and the more frequent flowering to the sturdiness.

HABIT.

Vegetative.

The plant is a herb, appearing as a great tuft of sword-like radicle leaves from one and one-third to two and one-half metres long (Plate xxxii, fig. 1). The older plants are clumps of closely packed bulbs, whose short, vertical, subterranean stems of about 15 centimetres in length increase to 3-5 metres at the time of flowering. The tallest stem observed was 5½ metres from ground level, a height attained in about three months. Almost full height is attained before floral development begins.

The tough leaves have a massive starch-filled base which thins to filminess at the edges and completely encircles the stem. The leaves on the stem elongated for flowering become shorter acropetally, being but one-third of a metre in the upper part of the stem. All the leaves, including the floral bracts, are initiated with a white, pithy tip, a solid prolongation of the young convolute lamina (Plate xxxii, fig. 5). The tip has numerous stomata, indicating a respiratory function. The one shown in Plate xxxii, fig. 5, terminating a lamina without chlorophyll, would be scarcely above the ground level. Before there is any clear sign of chlorophyll in the lamina the tip has become withered and brown, the lamina being still convolute, scarcely exposed to the air, and having the withering slightly extended on to it (Plate xxxii, fig. 6). By the time the lamina has partially expanded and developed chlorophyll, the tip has completely withered, as has the top of the lamina also (Plate xxxii, fig. 7). Most of the withered part falls off, leaving the dead and ragged end characteristic of the leaf.

Haberlandt (1914, p. 437), referring to similar structures in other types, regards the tip as a breathing organ for the gaseous interchange necessary during

the formation of embryonal tissue, and points out that the feature occurs frequently in connection with leaves of large area and a rolled vernation which reduces the respiratory surface. Being unnecessary when stomata are formed on the lamina, the appendage dies. Goebel (1905, p. 309) refers to such appendages as "plug tips". They occur on *Musa*, Zingiberaceae, and some Aroideae, all of which have convolute leaves. The tip closes the end of each lamina and fills up the space of the next oldest, the series of tips forming a solid plug which protects the bud. Lotzy (1911, p. 810) records Raciborski's interpretation of this "forerunner tip" (Vorläuferspitze) as serving a vital function till the lamina is prepared. He gives Goebel's interpretation with a detailed description in connection with *Doryanthes Palmeri*; but also says, ". . . der Spreite, ihre weissliche Farbe wird durch den Reichtum an Intercellularräumen, welche durch Spaltöffnungen mit der Atmosphäre in Verbindung stehen, verursacht. So ist sie also imstande, dem Blatte Sauerstoff zuzuführen." It seems to me that the "Plug tip" and "early vital function" interpretations are mutually exclusive in this case, since by the time the forerunner tip is exposed to the air it is already becoming discoloured in an early stage of withering. But if its function be that of a "plug tip", why the numerous stomata and numerous intercellular spaces? Arber (1925, pp. 112-117) considers a tip such as that in *Doryanthes excelsa* to be a vestigial petiole at the extremity of the leaf-base (figuring *D. Guilfoylei*). She says (pp. 112-114):—"Among the Monocotyledons, leaf-base phyllodes with petiolar apices are by no means confined to the *Liliaceae—Doryanthes* (*Amaryllidaceae*, fig. lxxxviii, 1, p. 116) . . . . afford other examples". And on page 117: "We thus take a leaf-base terminating in a simple petiole as the fundamental Monocotyledonous type . . ." The general pithy appearance of the tip and the scarcity of vascular bundles do not appear quite in line with this interpretation. In view of the plant's natural preference for the more moist and shaded situations, it is reasonable to regard the tip as a vestigial pneumatophore.

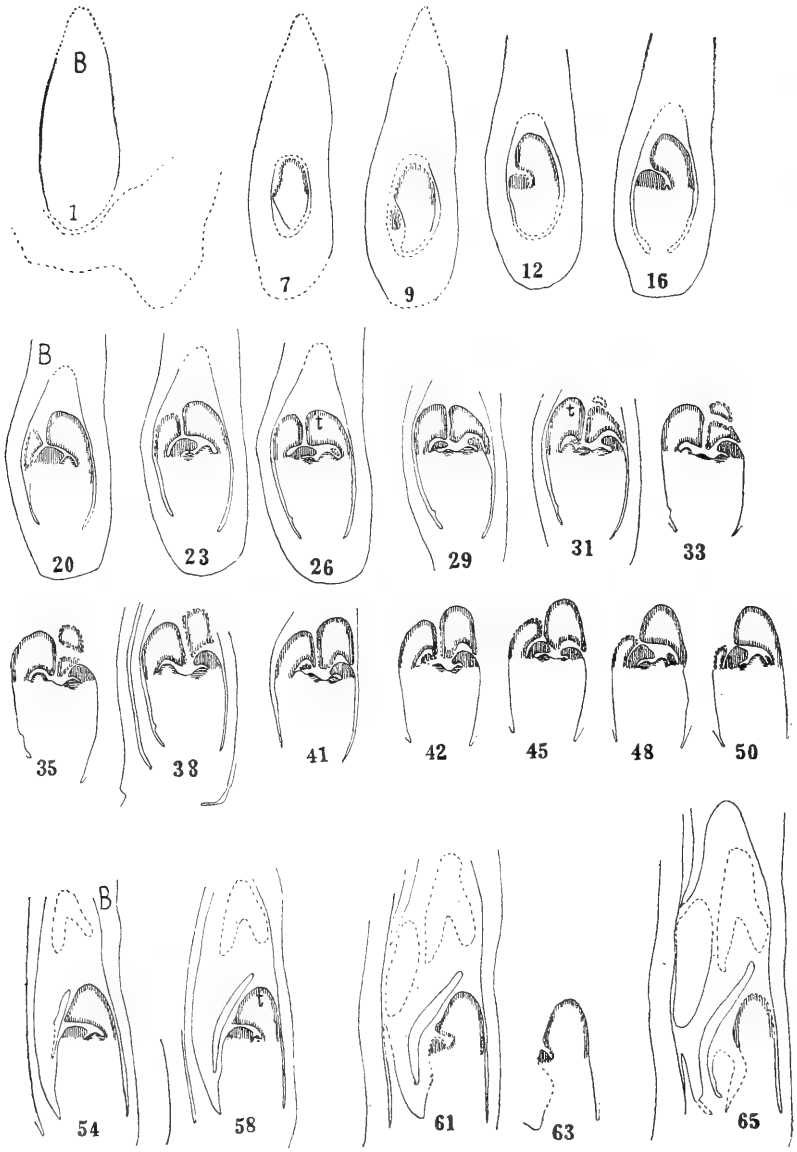
The leaves arise on the stem in an anti-clockwise spiral with a divergence of 5/13. This divergence is shown in Text-fig. 2, where six flowers (each in the axil of its bract) are included in just less than two and a half revolutions which appear clockwise in the figure because the aspect is from the base.

In the axil of each vegetative leaf there is a bud which is quite capable of development. The expansion of some of these buds is the chief means of increase in the plant's bulk. The stem of the initial bulb, having elongated and flowered, dies down so that the apex is destroyed. The axillary buds of the outer leaves then grow out from time to time, forming a clump of secondary bulbs round the parent bulb. These new bulbs repeat the process and so produce the great clumps, Plate xxxii, fig. 1. Flowering is possibly not essential to this process. About ten years elapse from the initiation of a bulb to the time of flowering.

Rendle (1904, p. 308) records the Agavaceae as "Rhizomatous plants with thick fleshy leaves and shortened internodes . . ." In the present description of *Doryanthes excelsa*, the habit of the plant has been described as bulbous with a decennial, not an annual cycle. *Doryanthes excelsa* seems to exemplify a bulb with an evergreen habit.

Floral.

The inflorescence is a large, globular, compound raceme with shortened main axis. A good specimen is as much as two-thirds of a metre in diameter. The young inflorescence is entirely enclosed within several large bracts which turn



Text-fig. 1.—Serial longitudinal section of a young flower with only perianth and stamens showing. The series passes from the front to the back; the numbers are the numbers of the sections in the series. Dotted lines indicate section of oblique surfaces. Vertical shading is for perianth; horizontal shading for stamens; outlined, for outer whorl; filled in, for inner whorl. *t*, the tip of the perianth. B, the subtending bract. In sections 54-65 parts of the bracts of other flowers appear. × 16

deep red and are forced apart as the inflorescence grows. All branching of the raceme is in the axils of further bracts, as are all the flowers, on the pedicle of each of which is a final, minute bract (C, Plate xxxiii, figs. 10 and 11). Text-fig. 2 represents a selection from a series of transverse sections through a young branch, showing the nine upper flowers in the axils of their respective bracts. Every inflorescence presents a great range in the ages of the flowers, from those showing primordia of members to those about the stage of fertilization. There are about 150 flowers to an inflorescence. Plate xxxii, fig. 3 presents the general appearance of an inflorescence; many of the lower flowers are completely withered, though others are unopened. It appears from this figure that the expanding of the flowers on a branch is acropetal, as is the expanding of the branches themselves.

The flowers are dark red outside and pinkish inside. Including the pedicle, they attain a length of 22 centimetres before expanding. Of this the ovary and perianth segments contribute about 8 centimetres each. The carpels are contained within and are adnate to a tube formed by the fusion of the lower part of the perianth members and the filaments of the stamens, the flower being described by systematists as epigynous. The three carpels have between them some 120 to 150 anatropous ovules. The expanded flower is about 8 centimetres across, the perianth lobes being slightly recurved. For half its length, the filament of the stamen is adnate to the perianth lobe opposite it; the other half, standing erect, holds vertically the long, yellowish-green, introrse anther shedding yellow pollen. Both perianth members and stamens are in two whorls of three members each. The fusion of their bases extends slightly beyond the ovary, forming a nectar cup. The long, tapering style has a small triangular stigma. The fruit is a large, loculicidal capsule, about 8×5 centimetres, whose light brown seeds have a papery wing.

When a flower head is cut off, the upper axillary buds of the flowering stem develop as floral branches (Plate xxxii, fig. 8). This phenomenon suggests that *D. excelsa* is derived from a type which flowered over the whole length of the stem. *D. Palmeri*, a more tropical species and therefore not having been under as much environmental change as *D. excelsa*, has not deviated as much from the original; its inflorescence is a thyrsus.

FLORAL ORGANOGENY.

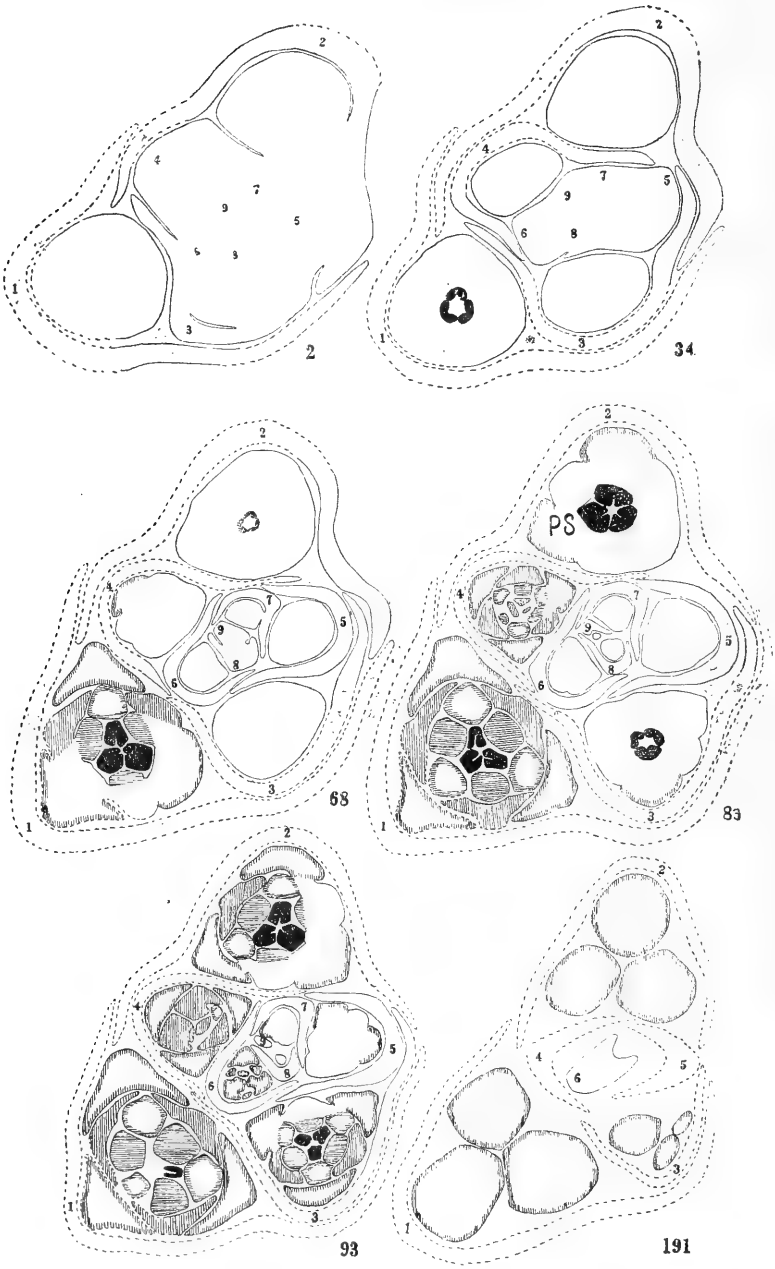
Description.

Methods of examination.

The organogeny was studied by serial sections and by a model made in artists' modelling material (Plate xxxiii, figs. 9-15). Sixty-six outline camera lucida drawings of a series of sections of a floral branch apex were transferred to sheets of modelling material of calculated thickness. The shapes being cut out were placed in order upon one another and pressed together. The completed model, when cut vertically in three nearly parallel planes, revealed clearly the internal structure of the young floral branch apex. The transverse magnification of the model was 70, but owing to the sheets of material being slightly too thick, the vertical magnification was 84.

There are three main portions in the Model (Plate xxxiii, fig. 9), left and right being two young flowers with only the base of the subtending bracts visible. In the centre are two bracts, each of which encloses a young flower. The other figures of the plate show the internal aspect of these three portions.

The Model is a vertical mirror image of the apex. In Text-fig. 2 the aspect is from the base towards the apex.

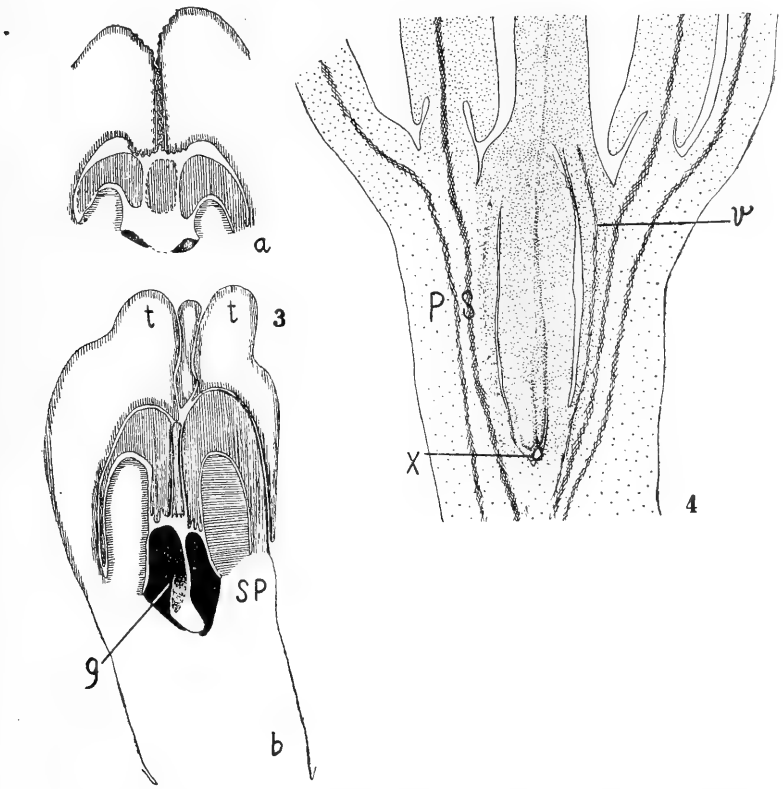


Text-fig. 2.—Serial transverse section from base to apex of a young floral branch, showing nine flowers and their subtending bracts. The numbers at the side of the figures are the numbers of the sections in the series. The flowers are numbered on the bracts in descending order of age. Dotted lines represent parts cut away in the preparation of the material for sectioning. Other conventions as in Text-fig. 1. Dead black for carpels. P.S., perianth-stamen tube. The aspect is from the base. × 15.

ORIGIN OF PARTS.

The several whorls arise in acropetal order, and the members as separate primordia. In Plate xxxiii, figs. 10 and 11, *a* is a young flower having the primordia of the outer whorl of perianth only; *b* has both whorls, two members of the inner whorl (p_2) appearing through the arch of outer whorl members. The outer whorl of staminal primordia is developed before the inner (Text-fig. 1), and the carpels arise last (Text-fig. 3, *a*, *b*; Plate xxxiii, figs. 14, 15). The members of successive whorls alternate (flower 1, section 83 in Text-fig. 2); and there is evidence that the members of each whorl arise in an anti-clockwise spiral.

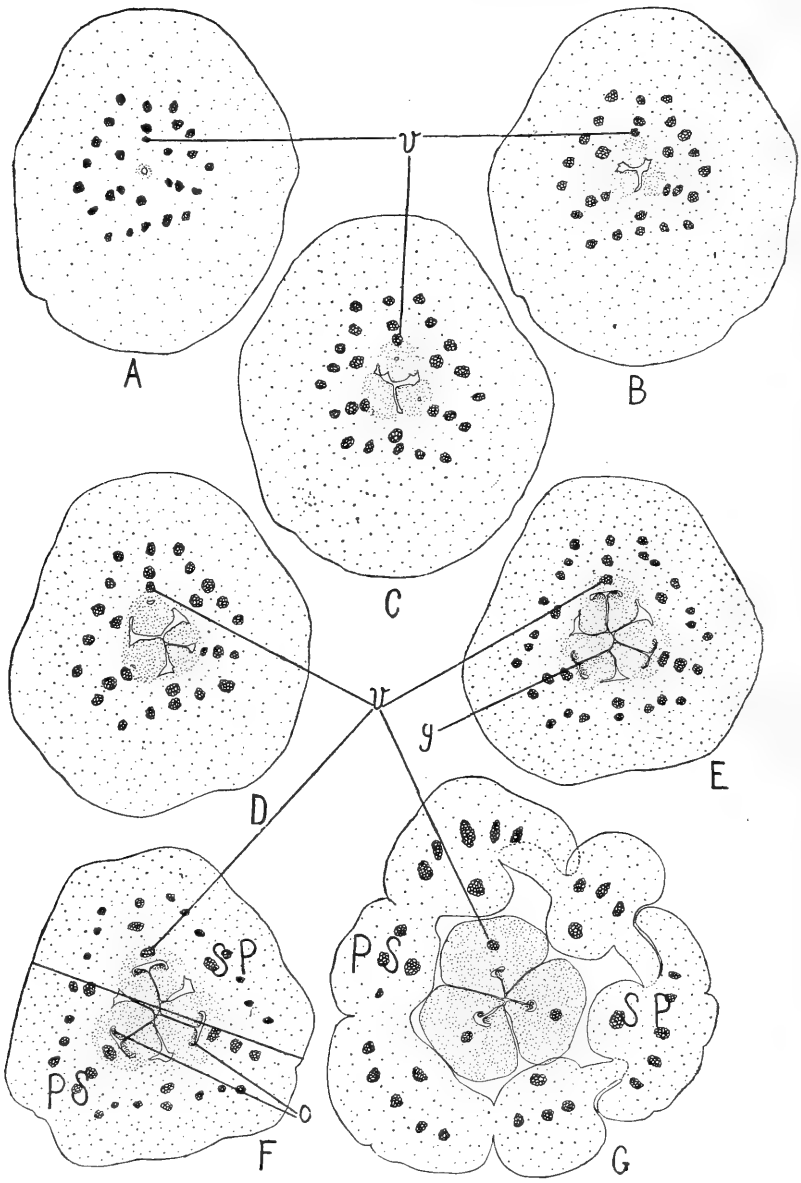
Up to the stage just before that shown in Plate xxxiii, figs. 14 and 15 and in Text-fig. 3, *b*, the meristematic activity has been confined to the several primordia. But at this stage the activity spreads across the thalamus and unites the primordia,



Text-fig. 3, *a*.—Longitudinal section of part of a young flower showing carpel primordia arising on the floor of a depressed apex. Shading conventions as in Text-figs. 1 and 2. × 36.

Text-fig. 3, *b*.—Longitudinal section of young flower about 3 mm. long. Perianth-stamen tube (SP) beginning to develop. *t*, tip on perianth segments; *g*, groove of the carpel. Shading conventions as in Text-figs. 1 and 2. × 21.

Text-fig. 4.—Longitudinal section of the base of a flower approximately 18 mm. long, about the plane shown by the line across Text-fig. 5, F. Carpellary tissue—deepest stippling—includes one midrib (*v*). P.S. Perianth-stamen tube; X. stalk region of carpel. × 11.



Text-fig. 5.—Series of transverse sections, at irregular intervals from the base up, of a flower 2·5 cm. long. The main vascular bundles are shown. The carpel tissue is indicated by heavier shading, that of their margins being still heavier. *g*, the line where the abaxial surfaces of the carpel are pressed together (the groove of Text-fig. 3, *b* and Plate xxxiii, figs. 9-15); *o*, ovule primordia; S.P. and P.S., perianth-stamen tube; *v*, vascular bundle of one carpel. The line across F is the position of the plane of section of Text-fig. 4. × 10.

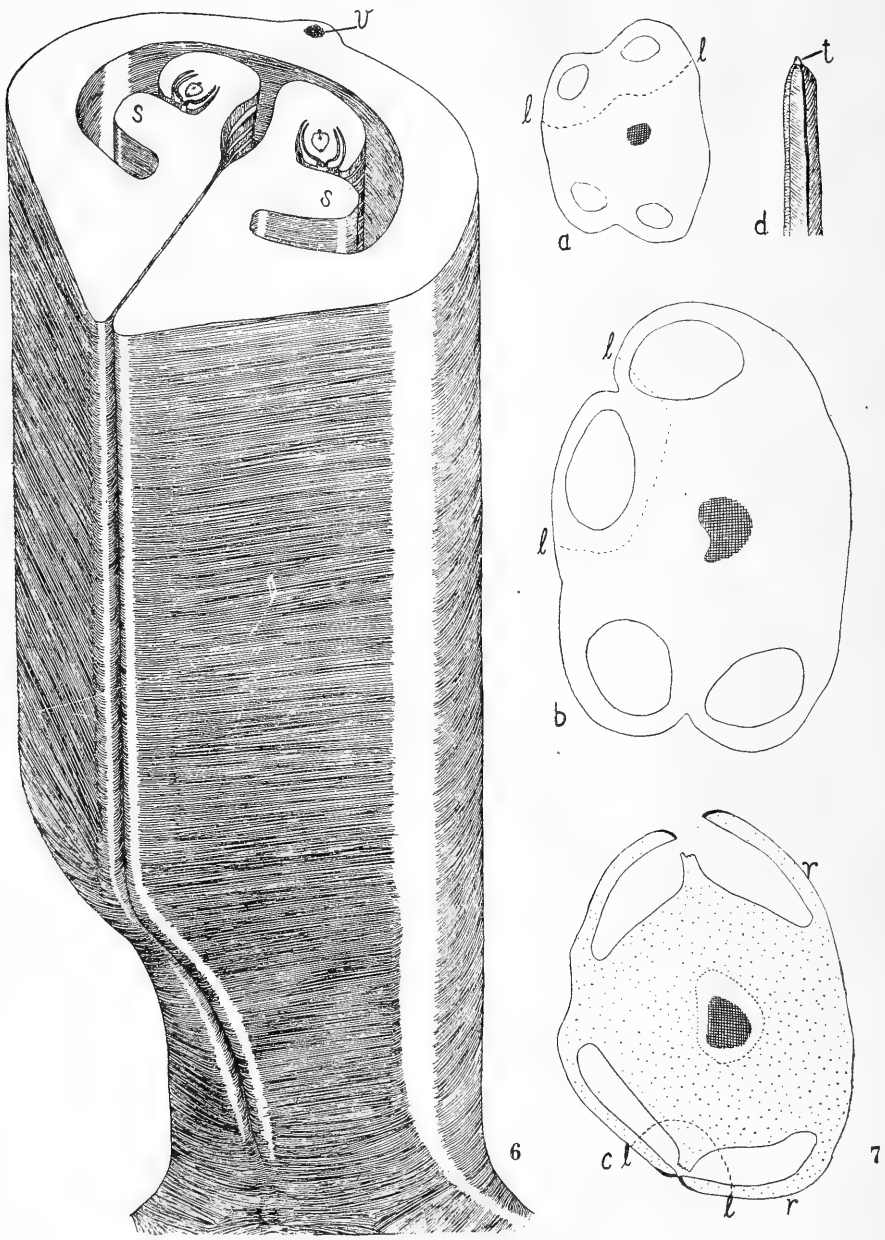
first, of each stamen to its subtending perianth segment, and afterwards, of all the perianth and stamen members. In the mature condition, therefore, the perianth segments and semi-adnate stamens appear as rising from the top of a perianth-stamen tube. This fusion has just begun in the stages represented by the figures last referred to; and in Plate xxxiii, figs. 12 and 13 the tube is quite distinct. In the region of the carpels this spread of meristematic activity is very limited, occurring only between the carpels and the perianth-stamen tube; so that in the adult condition the several carpels appear as being adnate to the tube, otherwise retaining their individuality. The result is that the flower is not truly epigynous, nor the ovary syncarpous, fusion not being complete in the transverse plane.

FORM OF THE PARTS.

The perianth segments soon arch in to the centre of the young flower and bend down for some distance, their tips temporarily developing long hairs. The arched part becoming rather thick, suggests, in the adult condition, a reduction of such a tip as occurs on the vegetative leaves and floral bracts (Plate xxxiii, figs. 10 and 11, Text-figs. 1 and 3, *b*, Plate xxxiii, figs. 12 to 15, and Plate xxxii, fig. 4). Of course the segment is only part of the perianth member, the rest being incorporated in the perianth-stamen tube (PS or SP). The fusion of the perianth members extends slightly above the place of separation from the carpels, forming a cup which becomes filled with nectar (Text-fig. 5, G, and *n* in Plate xxxii, fig. 4).

Plate xxxiv, fig. 17 shows part of two stamens where true lobing has begun. About this time the stamen becomes differentiated into filament and anther; compare Text-fig. 3 with 4 where the anther is seen also to be growing down around the insertion of the filament. The flower is now about six millimetres long. The filament at first grows very slowly, the anther keeping pace with the growth of the flower till the latter has become about 14 centimetres long, when the anther is about full length. The filament, taking up the growth, keeps the top of the anther close to the top of the perianth segments during further lengthening of the flower. Text-fig. 7, *a*, *b*, *c*, shows the growth of the anther in cross section. It has four broad lobes corresponding to the four sporangia, the lobes becoming almost obliterated in the adult condition. There is a tip to the adult stamen, reminiscent of the tip to the vegetative leaves (*t*, Text-fig. 7, *d*). Plate xxxii, fig. 4 shows the anthers broadly inserted on the semi-adnate filaments without definite connectives, and already dehisced. The anther second from left shows two sporangium walls rolled back (*cf.* the walls *r*, *r* in Text-fig. 7, *c*).

The carpels are interpreted as being derived from an ancestral form of the nature of an inrolled sporophyll with a row of abaxial sporangia along each margin. Text-fig. 6 is a perspective diagram of such a carpel, showing the lower portion only. It is in effect the appearance of the carpellary tissues when separated from the perianth-stamen tube. This interpretation is based on a consideration of the primordia, growth, and tissue differences of the carpels. The carpel is shown as distinctly stalked, in view of the appearance at *x* in Text-figure 4, and at the base of various serial transverse sections (*cf.* Text-figs. 2 and 5). If the "sporophyll" of Text-fig. 6 were unrolled, the ovules would be seen clearly to be at the margins (S) of the abaxial face, down which runs the midrib, *v*. In Text-fig. 5, where the main vascular bundles of the flower are indicated, the deeper stippling shows the limits of the carpellary tissue enclosing the midrib (lettered *v* for one carpel only); Text-fig. 4 shows the longitudinal appearance. The photo-micrographs of Plate xxxv, figs. 22 and 23 show the difference between the tissues of the carpel



Text-fig. 6.—Perspective, diagrammatic reconstruction of the base of a carpel, showing it as an involute leaf, with the ovules at the abaxial margin. S. margin; *v*, vascular bundle. × about 24.

Text-fig. 7, *a-c*.—Transverse sections showing growth of anther and loculus. Line ll indicates the area presented in other figures of this paper: *a*, Text-fig. 9; *b*, Plate xxxiv, fig. 20; *c*, Text-fig. 15. The cross-hatched area is the

and perianth-stamen tube. Where the carpels are free from the perianth-stamen tube as they merge into the style, their inrolled leaf form is well shown, Text-fig. 5, G. Further evidence in support of the above interpretation is that, except on the side next the perianth-stamen tube, each carpel is limited by its own epidermis, Plate xxxv, figs. 22 and 23. In Text-figs. 6, 19, 21, 24-27, and Plate xxxv, fig. 23, S is regarded as the margin of the carpel because of its general appearance and situation and because there is a flow of tissue from the carpel into it rather than from the carpel into the funiculus (Plate xxxiv, fig. 21). It is because of such an interpretation of this structure that the ovules can be stated definitely to be on the abaxial side.

That the incurved nature of the carpel is of long standing is shown by its initiation as a grooved structure (the primordial appearance of such a construction), Plate xxxiii, figs. 14 and 15, and Text-fig. 2. The groove, *g*, soon deepens (Plate xxxiii, figs. 12 and 13), later becoming the place of contact of the in-rolled abaxial surfaces (Text-fig. 5); about which time the ovule primordia make their appearance (*o*). When these are well on the way, the margin (S, in various figures) continues its deferred growth. The carpel is thus curved in towards the axis, out towards the midrib and then tangentially, the ovules being placed at the final bend. Except for the last curve, which does not extend vertically beyond the region of ovules, the construction described above extends to the top of the style.

In the region of the very small stigma (Plate xxxii, fig. 4, *st*) each carpel is once cleft, giving the appearance of six unexpanded lobes. The stigma is triangular in outline and covered with short hairs.

Discussion.

The nature of the floral organs occurring in *D. excelsa*, and the indications they provide for the interpretation of the parts of the flower in general will be briefly discussed.

The Foliar Nature of the Organs.

It seems to me that in *Doryanthes excelsa* the flower rather clearly suggests its origin from a leafy shoot. This opinion is based not only on the form of the various members, but also on the fact that the members of each whorl arise in a spiral having the same direction of rotation as that of the vegetative leaves (though, according to Engler, the Amaryllidaceae belong to the cyclic series of monocotyledons). Coulter and Chamberlain (1903, pp. 18 and 20) question whether the members of a whorl ever arise simultaneously. Scott (1917, p. 174) describes—after Payer—the sepals of *Lilium candidum* arising in spiral order, the remaining cycle members simultaneously.

The foliar nature of the perianth and stamens is indicated by their slight tip which is reminiscent of the forerunner tip of the vegetative leaves. Considering that the ovary is "inferior", *D. excelsa* presents the foliar nature of the carpels rather clearly. This is largely because, in the production of this condition, the meristematic zones spread across the thalamus between the stamen primordia and the backs only of the carpel primordia; and not between the carpels them-

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vascular bundle. In *c*, *r r* are the walls seen rolled back in the anther second from the left at the bottom of Plate xxxii, fig. 4; the stippling represents the extent of the "endothecium". *d*, perspective diagram of top of an anther, the dark line being the beginning of dehiscence; *t*, the "forerunner tip". *a*, × 36; *b*, × 21; *c*, × 10; *d*, about natural size.

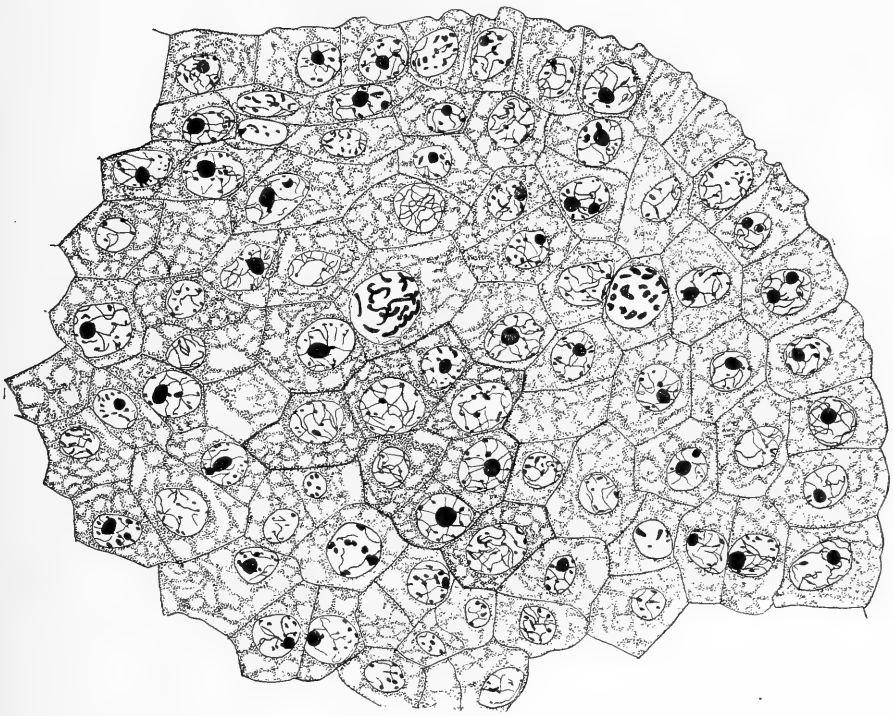
selves, each of which is bounded by its own epidermis except at the back. This interpretation is facilitated by regarding the structure S in Text-fig. 6 as the margin of the involute sporophyll, and not a placenta. The ovules are therefore on the abaxial side at the margin, being in line with Jeffrey's (1917, pp. 247-251) classification of the Angiosperms among the Pteropsida. Cheauveaud (1892, p. 141) describes a similar structure of the carpel among the Asclepiadaceae, and interprets the ovules as abaxial. Goebel (1905, p. 558) states that the occurrence of ovules on the under surface of carpels is really not a rare phenomenon, instancing *Erythraea pulchella* with its strongly incurved margins united over a relatively small area. In the case of *Doryanthes excelsa* the phenomenon is particularly clear. It is interesting to note that Farrell (1914, p. 429) records stomata on the inner surface of the carpels of the Amaryllidaceous *Cyrtanthus sanguineus*, the numerical ratio compared with the outer surface being 8 : 5.

Although to outward appearances the ovary is normally inferior and syncarpous, the minute investigation carried out shows that the carpels are not fused to one another, but are distinct, each with its own epidermis, and are therefore not strictly syncarpous. Nor is the flower truly epigynous, being rather like a perigynous flower wherein each carpel is adnate to the perianth-stamen tube. These considerations further emphasize the foliar nature of the carpels. Coulter and Chamberlain (1903, p. 22) combat any attempt to describe the carpels (or stamens) as transformed leaves, claiming that they have been established long enough to be regarded as organs *sui generis*. But that status is not denied by a reference to their origin. Other writers are quite definite in referring the carpels to leaves, e.g. Goebel (1905, p. 555), Rendle (1904, p. 149), Bower (1919, p. 252 and 255). Bower's figures 201 and 203, of Lily and *Iris* ovaries respectively, are comparable, *mutatis mutandis*, with Text-figures 5, E, F, G of this paper, there being suggestions of lines of demarcation between the carpels. A comparable drawing is also given by Church (1908) in connection with *Narcissus* (Fig. 2, II, p. 122).

Coulter and Chamberlain (1903, pp. 18 and 20) deplore the lack of detailed investigation of the organogeny of flowers. During the foregoing study several aspects of this deficiency have come under notice, and seem worth brief reference. Most of the apperceptive basis and source of terminology for the early students of organogeny was the work of the systematists who, perforce, knew only the adult flower. It was therefore natural that the younger stages of floral development should be interpreted and designated in the light of the adult flower; whereas the true presentation must be gained by laying interpretative emphasis on the younger stages, in the light of which the adult condition should be described. Secondly, attention does not seem to have been directed to the tissues of the organs concerned where "fusion" is recorded. And in the third place the phraseology is not always precise. These three points will be discussed chiefly as regards their connection with *Doryanthes excelsa*.

By interpretation from the adult condition, the Amaryllidaceous flower is described as having the torus extended into a long tube, on the top of which are the perianth segments and stamens, while the carpels line its inside face. Church (1908), describing the organogeny of *Galanthus* and *Narcissus*, does not figure the very earliest stages before all the whorls are present and does not show tissues. Describing *Galanthus* (pp. 21-22) he says, "The flower stem . . . dilates to a very distinct cup-like form, the *receptacle-crater*; the perianth segments arise from the top of the rim towards the outer edge, the stamens just on the rim, while the

carpels arise from the whole of the inner slope, and are so pressed together that they fill the cavity and only leave a small slit between them. The point at the bottom of this slit is therefore the apex of the floral axis, and the outline of the crater is obtained by drawing a line through the points of origin of all the members." He refers to Fig. 3, which is very similar to Text-fig. 3, *b* and Plate xxxiii, figs. 14, 15 of this paper. But my Plate xxxiii, figs. 10, 11 and Text-figs. 1, 2 and 3, *a* show that the "receptacle crater" is really a tube due to the extension of the meristems of the perianth and stamen primordia across the torus which, when the primordia "arise", is but a slightly depressed stem apex. Text-figure 3, *a* shows the carpels arising before this crater appears. Therefore I have interpreted the tube of the flower as a "perianth-stamen tube" on account of its ontogeny, not on account of its adult appearance.



Text-fig. 8.—Transverse section of corner of young anther, showing possible origin of the archesporium or of the sporogenous tissue, more deeply shaded and outlined. × 781.

With regard to the phraseology: The term "axile", is surely misleading when applied to ovules which are on the margin of the carpels, when these carpels, though closely pressed together and appearing at some stages to make a solid axial tissue, are bounded each by its own epidermis and leave a clear space above the suppressed apex of the axis (X, Text-fig. 4). Compare with Church (1908, p. 122) referring to *Narcissus*: "The carpels fuse very imperfectly, and the apex of the floral axis may thus be observed at the base of the ovary, that is to say at the bottom of the crater (Fig. 4)". The term "fuse" leads to the necessity for figuring tissues in organogeny. For can two organs each with its distinct epidermis

recognizable in the adult condition (Text-fig. 27) be described as fused (Plate xxxv, figs. 22 and 23, are of younger stages), no matter how closely they may be appressed. By studying the tissues in *Doryanthes excelsa*, the line of demarcation between the carpels and the perianth-stamen tube could be seen and was noted as enclosing the midrib of the carpel (Plate xxxv, figs. 22 and 23). The correct interpretation of the floral structure was thus facilitated. A brief examination of a transverse section of an ovary of an *Agave* sp. showed a similar condition in regard to tissue details and epidermes as in *Doryanthes excelsa*.

SPORANGIAL STRUCTURES.

Description.

The term "sporangial structures" will include the sporangium itself and any tissues which are intimately associated with the function of the sporangium or its place of origin in space. In time, the term will be extended to include these structures until the spores have completely germinated.

MICROSPORANGIAL.

Collective.

Relation to the Sporophyll.

As will be shown later it is not possible to give a precise designation of the microsporangium in this case, but it will be taken to include all tissues which have a possible derivation from an archesporium. Plate xxxiv, fig. 20 almost coincides with the limits of the microsporangium, except that a small part of a second one is included on the right. The four sporangia, though slightly protruding in the younger stages, are scarcely so in the adult stage (Text-fig. 7, *a*, *c*). Each of these massive sporangia can be traced in origin to a very limited region of the sporophyll, so that the wall to the inside of the loculus can have been derived from a primary parietal tissue.

Initiation of the Sporangium.

There is no clearly marked archesporium, either hypodermal or more deeply sunken, but the sporogenous function appears to settle gradually on a small group of cells sunken about three layers; and similarly the primary parietal function might be regarded as settling gradually on these externally adjoining layers. The transverse sections of anthers, slightly progressive in age, depicted in Plate xxxiv, figs. 16 and 17, show no sign of a definite archesporium, but a settling of sporogenous function on a group of cells sunken about three layers (Plate xxxiv, figs. 18 and 19). Text-figure 8 shows a corner of an anther slightly younger than those of Plate xxxiv, fig. 17. The drawing was made very carefully with the camera lucida, the protoplasm being traced as accurately as possible. Sunken three or four layers there appears a group of about eight cells with slightly denser cytoplasm and the ratio nucleus to cell greater (the outside walls have been drawn more heavily). This is in line with the gradual settling of function till the very definite primary sporogenous group is initiated (Plate xxxiv, figs. 18 and 19) surrounded by a region of occasional crushing. The cells between this group and the epidermis might be regarded as the primary parietal group. So the sporangium has been definitely initiated, though the staining has revealed no strictly localizable archesporium.

Differentiation of tissues.

The sporangium, when first clearly discernible, is already differentiated into primary sporogenous and parietal tissues (Plate xxxiv, figs. 18 and 19). The

tapetal function is of diverse origin, part coming from the primary sporogenous group and part from the primary parietal group. A couple of rows of cells (t_3 in Text-fig. 9), next surrounding the young sporogenous group, are in general smaller than those beyond. And a zone of cells (T), staining less deeply, with less copious cytoplasm and smaller nucleoli, is formed later in the periphery of the sporogenous group (Text-fig. 10). The two zones t_3 and T_1 provide the tapetal function, the latter zone being the true tapetum.

Several.

Sporogenous Tissue.

The sporogenous tissue will be described in a separate section of the paper.

Parietal tissue (Wall).

Two zones of the wall are indicated very clearly in Text-fig. 10. In this figure the wall is at maximum development, 11 to 13 layers thick, the time being just before the mother cells are organized. The inner zone extends round the inner face of the sporogenous group.

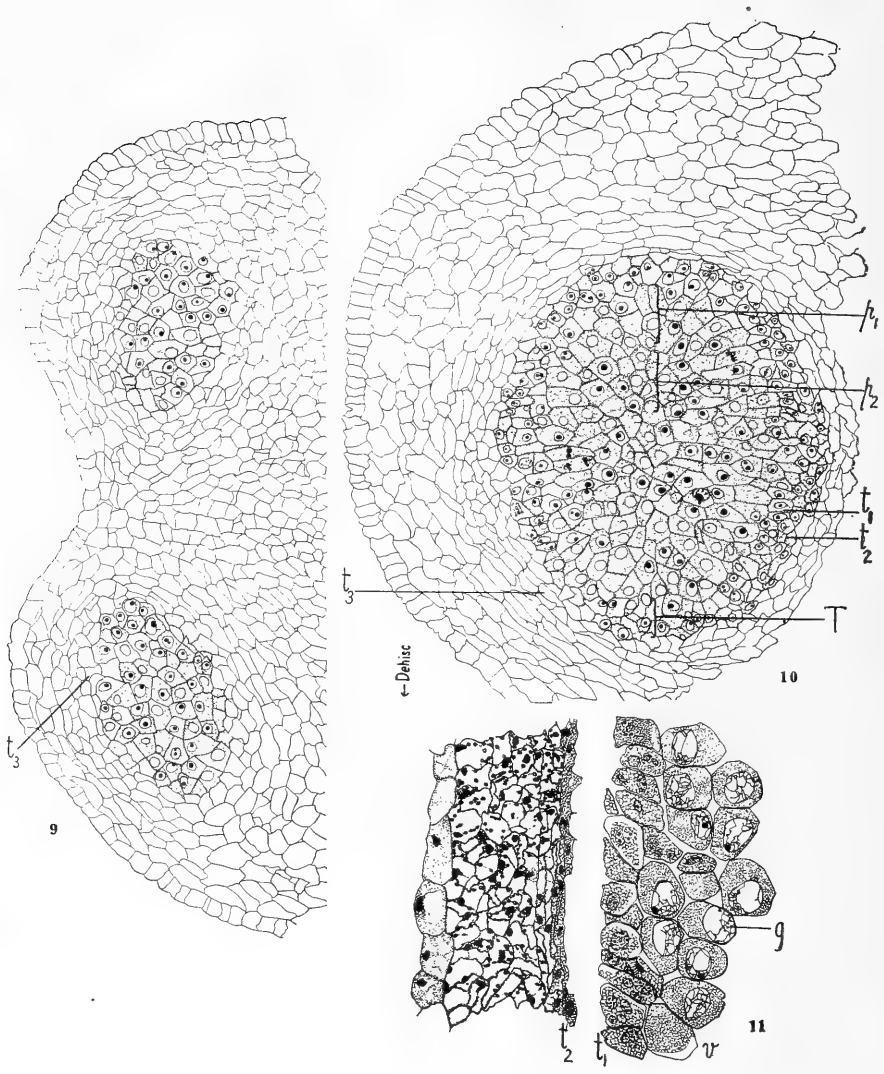
While the mother cells are attaining to synapsis there is an accumulation of starch in the wall tissue and the anther tissue (Plate xxxiv, fig. 20, and Text-fig. 11), except in the immediate vicinity of the vascular bundle and under the sinus between the pairs of sporangia. The starch is still present after the completion of tetrad formation (Text-fig. 12). About the time of the division of the microspore nucleus, the starch is converted into bands of cellulose thickening on the walls of the cells concerned (Text-fig. 15). Under the sinus the cells are much smaller and are roughly isodiametric, compared with the other large cells which are elongated tangentially to the loculus. The epidermal cells are unthickened, and those in and bordering the sinus contain a dense mucilaginous substance, staining very deeply with safranin and haematoxylin. The tensions induced among these variously constructed elements ultimately produce dehiscence; the beginning is shown in Text-fig. 15.

Tapetal Tissues.

Under the term "tapetal tissues" are included all those histological elements which are used as food-stuff in the production of the spores. The term "tapetum" is reserved for one particular set of elements, derived from the sporogenous tissue.

The early sign of disintegration for nourishment which occurs in the anther tissue and in the (possibly) primary parietal tissue, may be an artifact (Plate xxxiv, figs. 18 and 19) due to the processes of preparation, since it is absent in slightly older stages (Text-fig. 9).

The tapetum (T, Text-fig. 10) has an inner layer of cells radially long compared with those of its outer region of one or two layers. Though these two zones (t_1 and t_2) appear at first to be less densely cytoplasmic and less deeply staining, they later become very coarsely cytoplasmic and more deeply staining (t_1 and t_2 in Text-fig. 11, Plate xxxiv, fig. 20 and Plate xxxv, figs. 24, 25 and 29). The difference between the two zones increases, the cells of the inner becoming very large and multinucleate, those of the outer remaining small and uninucleate. The outer zone becomes crushed at the time of synapsis (Text-fig. 11 and Plate xxxiv, fig. 20), and is used up by the time the spores are formed, being scarcely discernible in Plate xxxv, figs. 25 and 29 (t_2). The inner layer of the tapetum develops vigorously, its cells increasing not so much in number as in size. They



Text-fig. 9.—Transverse section of two anther lobes showing disposition of the early sporogenous and parietal tissues. t_3, inner zone of the parietal tissue. × 182.

Text-fig. 10.—Transverse section of an anther lobe showing the origin of the tapetum, and the zonation of wall, tapetum and sporogenous group, p_1 and p_2, outer and inner zones of sporogenous group. T, tapetum; t_1 and t_2, its inner and outer zones; t_3, inner zone of parietal tissue which will be crushed. × 180.

Text-fig. 11.—Longitudinal section of part of an anther showing microspore mother cells in late synapsis. (Chromatin loops). Starch is present in the outer zone of the wall, the inner zone having been crushed. *g*, apparent "globule", appearance due to vertical or crossed threads; t_1 and t_2, inner and outer tapetal zones, between which is a line of shrinkage; *v*, vigorous mother cells adjacent to tapetum. × 182.

become multinucleate with many nucleoli to the nucleus, and occasionally project slightly amongst the mother cells, to which they adhere rather than to the disintegrating outer tapetum (t_1 and t_2, Text-figs. 11, 12, 13, Plate xxxiv, fig. 20, and Plate xxxv, figs. 25 and 29). The inner tapetum persists (Plate xxxv, fig. 24) till the division of the microspore nucleus, and then is used up.

The two other main sources of tapetal function are the inner layers of the parietal tissue and some of the more central mother cells. The first has disappeared by the time of synapsis, the wall, originally eleven to thirteen layers thick, having then only the five or seven layers of the large-celled outer zone (see Text-fig. 11 and Plate xxxiv, fig. 20). The second is correlated with the central, more vacuolate region of the sporogenous tissue (Text-fig. 10)—furthest from the supply of nutrition derived from other tapetal sources—where some of the mother cells disintegrate.

The walls on the tapetal cells in contact with the young microspores become reticulately thickened like the exine of the spores (compare Text-figs. 13 and 14). The same phenomenon is seen in the photomicrograph presented in Plate xxxv, fig. 24. After the tapetum has disappeared, this "exine" remains lining the loculus, Text-fig. 15.

The tapetal functions might be summed up as follows: During the initiation of the sporangium, contiguous somatic cells serve any nutritive function required. During the organization of the true tapetum while the sporogenous group is enlarging, the crushed inner zone of parietal tissue provides nourishment. The outer zone of the tapetum and some of the more central mother cells are used up during tetrad formation. The inner zone of the tapetum appears to organize the supply of nutrition to the mother cells and young spores, but when the development of the "endothecium" hinders the supply, other histological sources being exhausted, this inner zone itself becomes the nourishment of the microspores during the first nuclear division of their germination.

An exceptional origin of Sporangia.

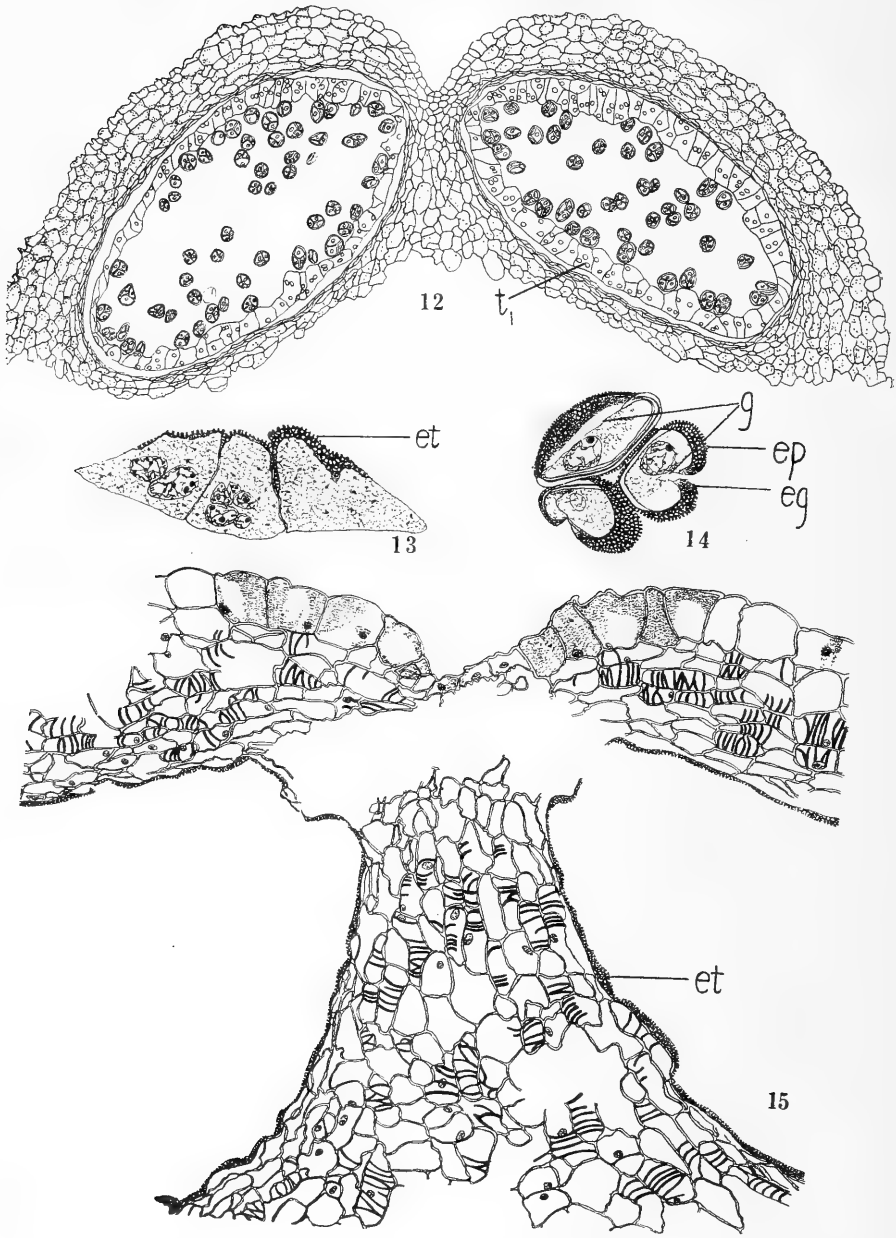
An exceptional case was observed where, instead of four separate sporangia arising, there had been two archesporia each of which bifurcated as the anther increased in length. Text-fig. 16, a serial transverse section of an anther, passing downwards from the tip, shows one loculus (*a*, *b*) becoming constricted (*c*, *d*) and finally divided (*e*); while a second loculus (*e*, *f*) becomes divided (*g*, *h*). The stomial region also divides, its branches occurring between branches from different loculi. The growth of the anther in length takes place mostly in the basal region; consequently it appears that only two archesporia were originally laid down, bifurcating later. No other example has been observed in this investigation.

MEGASPORANGIAL.

Collective.

Position, Initiation and Differentiation.

The term megasporangium is here limited to those tissues traceable in origin to a unicellular archesporium. The megasporangium of *D. excelsa* occurs, partially sunken, on a receptacle (nucellus) which is situated on the abaxial margin of the sporophyll. The receptacle which is curved so that the sporangium is brought close to the surface of the sporophyll, produces two outgrowths (integuments) of the nature of indusia. The whole is the ovule. In Text-fig. 27 the sporangium is enclosed by a heavy line (*p*), the one functional spore having germinated at the stage represented.



Text-fig. 12.—Transverse section of two anther lobes showing young spore tetrads, and inner tapetum (t_1). Starch grains are in wall and anther tissue. × 63.

Text-fig. 13.—Inner tapetal cells showing heavy granular cytoplasm, multinucleate condition and reticulate "exine" (*et*). × 495.

Text-fig. 14.—Three spores, of a tetrad in the wheat-grain condition, cut along the groove, transversely and obliquely. *ep*, thickened part of the exine;

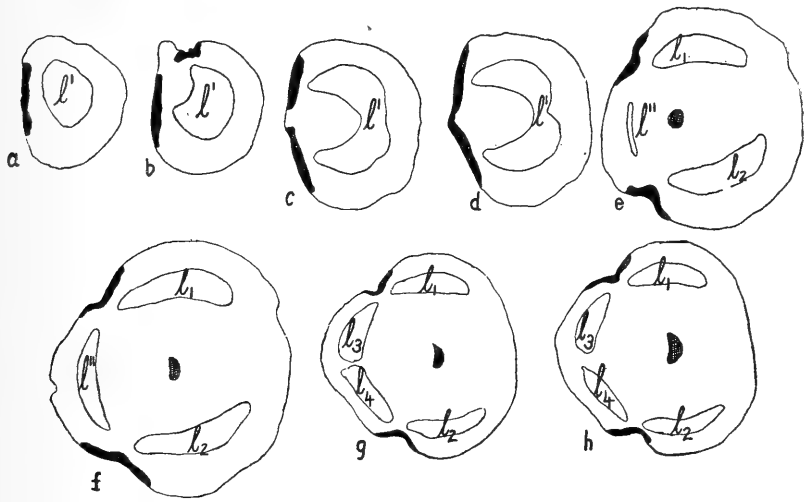
The megasporangium is early initiated at the tip of the receptacle (nucellus) as a unicellular hypodermal archesporium (Text-fig. 17).

The archesporium undergoes the normal periclinal division to form the primary parietal and sporogenous cells (*w* and *p*, Text-fig. 18). The receptacle, beginning to bend about this time, becomes differentiated into funiculus (*f*), chalaza (C), and a further portion lying to each side of and projecting slightly beyond the sporogenous cell (Text-figs. 20 and 24). The indefinite tapetal function is carried out by adjacent cells of the receptacle and parietal tissue and by the non-functional spores (Text-figs. 20 to 26, 42, 43 and Plate xxxv, fig. 27).

Several.

Sporogenous Tissue.

The sporogenous tissue will be described in a separate section of the paper.



Text-fig. 16.—Serial section, from the apex down, of an anther, showing an origin of four loculi by the bifurcation of two initials. 1′ and 1″, apices of the two primary loculi which divide into the branches l_1, l_2 and l_3, l_4 respectively. The dead-black is the stomium region. *a-f* × 20, *g* and *h* × 10.

Parietal Tissue.

The ultimate development of the parietal tissue is very massive. By a few anticlinal divisions the primary parietal cell develops into a single layer across the top of the primary sporogenous cell (*w* in Text-figs. 19 and 20). Its further growth can only form a cap above the sporogenous cell which is distinctly sunken in the receptacle tissue. Periclinal divisions, setting in before synapsis, make a three-layered wall at that time (Text-figs. 21 to 23). Further divisions increase the layers to about seven at the stage of the functional spore (Text-fig. 42 and Plate xxxiv, fig. 21).

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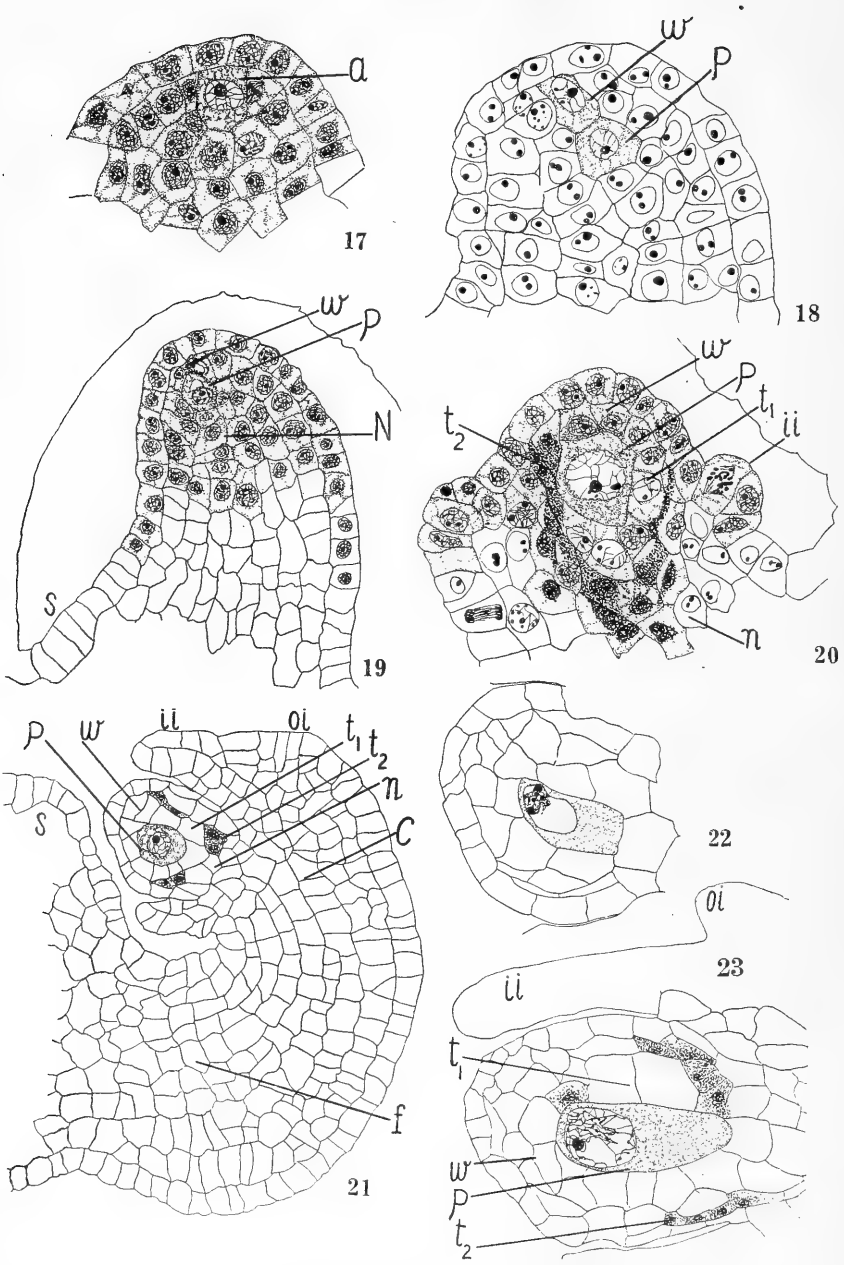
eg, unthickened part of the exine facing the groove; *g*, bottom of the groove. × 495.

Text-fig. 15.—Part of transverse section of two loculi of an anther showing the beginning of dehiscence, the dense contents of certain epidermal cells bordering the sinus, the bands of thickening in the tissues, the persisting "exine" of the inner tapetum (*et*). × 147.

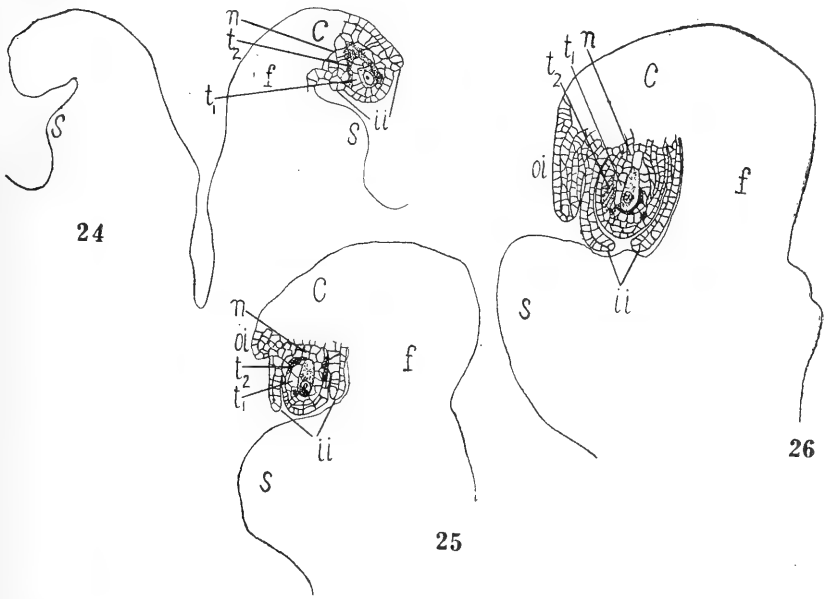


Text-figs. 17-23.—Longitudinal sections of the receptacle (nucellus) showing the development of the megasporangium from the archesporium to late synapsis in the mother cell. 17: *a*, hypodermal archesporium, × 430. 18: *p*, primary sporogenous cell; *w*, primary parietal cell, × 410. 19: N, receptacle (nucellus); *p*, primary sporogenous cell; S, margin of the sporophyll; *w*, two cells from the primary parietal cell (*cf.* Plate xxxv, fig. 23), × 295. 20:

During this development the wall attains a markedly radiate appearance, which is clearly shown in the photomicrograph presented on Plate xxxv, fig. 27. There is a slight beak (*b*) projecting into the micropyle. The parietal tissue is here quite distinct in appearance, compared with the receptacle (nucellus) tissue at the sides of the embryo-sac. It is still evident in the seed, the crushing of its inner layers having been compensated by cell division in the outer regions.

Receptacle tissue.

The receptacle, in the adult condition, is massive, a feature which becomes manifest soon after the bending differentiates it into funiculus (*f*), chalaza (C), and the further portion, generally known as "nucellus" (*n*) which undercups the mother cell and derivative structures. This "nucellus" is very broad towards the chalaza, producing a pear shape. The funiculus extends into the loculus to form the beginning of what will be the wing of the seed (Text-fig. 27). The development of the funiculus, chalaza and "nucellus" is to be seen in Text-figs. 19, 21, 24-27, Plate xxxiv, fig. 21, and Plate xxxv, figs. 23 and 27.



Text-figs. 24-26.—Stages of the development of the ovule. The differentiation of the placenta, and growth of the integuments. *n*, "nucellus"; C, chalaza; *f*, funiculus; *ii* and *oi*, inner and outer integuments; S, margin of carpel; t_1 and t_2, inner and outer zones of tapetal function. × 90.

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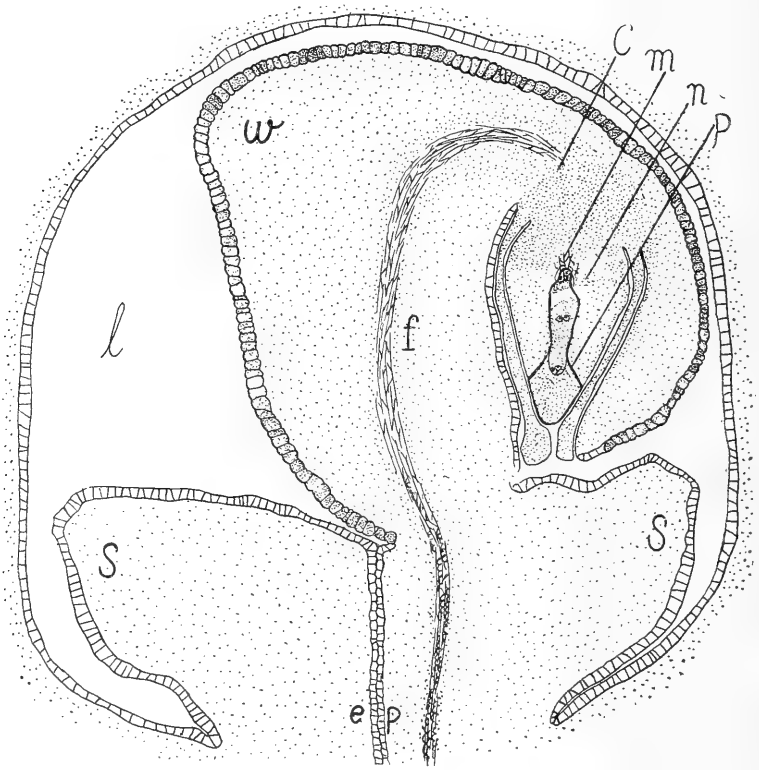
receptacle curved; *ii*, inner integument primordium; *n*, "nucellus", *p*, primary sporogenous cell becoming mother cell; t_1 and t_2, inner and outer zones of tapetal function; *w*, wall layer of four cells, × 430. 21: Receptacle completely curved and differentiated into funiculus (*f*), chalaza (C) and "nucellus" (*n*); *ii*, inner integument; *oi*, outer integument primordia; *p*, megaspore mother cell; S, margin of carpel; t_1 and t_2, inner and outer zones of tapetal function; *w*, parietal tissue, × 250. 22: Early stage of synapsis in the mother cell; wall about 2 layers thick × 410. 23: Late stage of synapsis (chromatin loops) lettering as in fig. 21. × 430.

The inner integument is originated by increased growth in a ring of epidermal cells level with the base of the young mother cell about the time the placenta begins to bend sharply. In similar manner the outer integument starts soon afterwards, though the bending of the placenta prevents it being a complete ring (Text-figs. 20 and 21). Developing as a collar two cells thick, the inner integument grows faster at first than the massive outer integument, which catches up after the inner has bent over the top of the sporangium (Text-figs. 23, 25, 26 and Plate xxxiv, fig. 21). The inner integument forms a micropyle of medium length. In this region it is more than two layers thick, the two sides of the integument appearing club-shaped in longitudinal section of the ovule (Text-fig. 27, Plate xxxiv, fig. 21 and Plate xxxv, fig. 27). The cells lining the micropyle are elongated and glandular.

The early receptacle (nucellus) tissue is uniform (Text-figs. 18 and 19), but about the time the inner integument arises, some of its cells adjacent to the mother cell take on a tapetal function (t_1, t_2, Text-fig. 20). As the megaspore begins to germinate, certain cells of the "nucellus" at the chalazal end of the



Text-fig. 27.—Transverse section of a loculus showing a mature ovule. Epidermis has dense contents. The megasporangium, with functional spore germinated, is heavily outlined. *ep*, appressed epidermes of abaxial sides of carpel (sporophyll); *f*, funiculus; C, chalaza; *l*, loculus; *m*, thick-walled cells at base of sac; *n*, "nucellus"; *p*, sporangium; S, margin of carpel (sporophyll); *w*, beginning of wing development of funiculus. × 66.

growing sac become very thick walled with a mucilaginous appearance; the thickening extends for a depth of several cells towards the vascular supply which ends blindly in the chalaza (*m* in Plate xxxv, figs. 27 and 28 and Text-fig. 27).

Tapetal Tissues.

The receptacle cells of tapetal function are in two zones, the inner of which, t_1, is composed of large clear cells and organizes the nutrition received from the disintegration of the outer, t_2 (Text-figs. 20-26). The zonation is very irregular, but persists till the production of the spores; after which it is obliterated by the growing sac. The growth of the sac, by crushing adjacent placental and parietal cells and the non-functional spores, brings these elements into the tapetal function (Plate xxxv, fig. 27, Text-figs. 42 and 43).

Discussion.

Relation of Sporangia to Sporophyll.

Though the anther, which is more than four microsporangia, and the ovule, which is more than a megasporangium, are now organs *sui generis*, it seems desirable to describe them in terms which indicate their continuity with the ancestral forms. Risking the charge of using a rigid morphology, such an attempt has been made in this paper. In the case of some plants, great modifications in structure or displacement of position, or both, make such a presentation difficult. *Doryanthes excelsa* presents neither of these difficulties. In the megasporangium the archesporium is clearly marked. In connection with the microsporangium, however, a difficulty is introduced by the failure to locate a definite archesporium. This may be due to the primary sporogenous function gradually settling on a small group of cells (Plate xxxiv, figs. 16 to 19 and Text-fig. 8), or to a strictly localizable archesporium not manifesting the typical staining reactions referred to by Coulter and Chamberlain (1903, p. 33). This doubt only involves the allocation of the wall of the sporangium.

If Plate xxxiv, figure 16 record the hypodermal origin of the microsporangium, then all the apparent wall tissue is sporangial. If Text-figure 8 present the position of the archesporium from which are formed primary parietal and primary sporogenous cells, then not all the apparent wall can be regarded as sporangial, and the zonation of this wall shown in Text-figures 9 and 10 would be accounted for, the region t_3 being the true parietal tissue of the sporangium, and the larger cells to the outside sporophyll tissue. The evidence does not warrant a definite pronouncement, though I regard it as favouring the latter interpretation, in which case an interesting analogy could be drawn between this sporangium and that of the Eusporangiate Filicales, where the archesporium is more or less deeply sunken. Campbell (1898, p. 8) describes the archesporium in *Lilaea subulata* as arising from the outermost layer of the plerome. In the present instance the archesporium is too far from the vascular bundle to allow of such an origin. The non-hypodermal origin of the archesporium has also been recorded for *Naias flexilis* and probably *Zannichellia* (Campbell, 1897, pp. 13 and 41).

The position of the archesporium in the hypodermal layer of the receptacle (nucellus) is quite normal for the megasporangium. The recognition of the structure S in Text-figure 6, as the margin of the sporophyll and not a placenta, and the restriction of the term sporangium to the products of the archesporium, involve modifications in the terminology of the ovule. Only a primary parietal cell or its products can be strictly regarded as sporangium wall, and therefore a tissue so derived is no more "nucellar cap" than is the embryo sac part of the

"nucellus". Coulter and Chamberlain (1903, p. 62), referring to the primary parietal cell, say, ". . . . we shall call it the parietal cell—that is, a cell that develops in part the wall of the embedded sporangium". In view of the implied homologies, it seems better to regard as wall only the tissues derived from this cell. Under this view, the "nucellus" becomes part of the receptacle, bearing a monosporangiate sorus.

There is an histological distinction between sporangium wall and receptacle tissue (Plate xxxiv, fig. 21, Plate xxxv, fig. 27, and Text-fig. 42). The chalaza and funiculus are regions of the receptacle, and the integuments are indusial outgrowths from it.

A point in connection with confusion of terms from the aspect of implied homology may be mentioned here. In the Filicales the receptacle is a region of the *sporophyll* on which *sporangia* arise; in the Angiosperms the receptacle is the term generally used to refer to the region of the *stem* on which *sporophylls* arise. The term has been used in this paper to correspond with its use in connection with the Filicales.

The interpretation given above for the sporangial structures is strongly suggested by the appearances in *Doryanthes excelsa*. The chief objection will probably be raised in connection with the megasporangium which is generally regarded as being represented by the "nucellus." Goebel (1905, p. 614) says: "We distinguish usually in it* a stalk or funicle, one or more integuments, and the nucellus enveloped by the integuments. The nucellus is the megasporangium. This is undoubted." But previously he says, in reference to the sporangia of Pteridophyta (p. 601), "So far as I can see the simplest expression of the facts regarding the first inception of the sporangia is this: the essential content of the sporangium—the sporogenous cell-mass + sporangial wall—can be traced back to a superficial cell, cell row or cell mass. This divides by periclinal walls. In this way the primordia of the wall and the sporogenous cell-mass are separated. . ." This restricted origin does not seem consistent with regarding the "nucellus" as the sporangium, but is consistent with the interpretation given in the present paper. Bower (1923, p. 258) refers the origin of the sporangia to definitely localized regions, of one or few cells. Coulter and Chamberlain (1903, p. 62) say that the primary parietal cell "develops in part the wall of the embedded sporangium". If the *nucellus* is the *sporangium*, in *what* is the *sporangium* embedded? The interpretation given in this paper appears to be implied by the statement of Coulter and Chamberlain. The contention is that this interpretation is supported by the accounts of other writers (quoted), and is necessary for accurate homologies. Campbell (1918, p. 603) states: "The integument of the ovule is, with very little question, homologous with the indusium"; and indicates a great similarity between the young megasporangium of *Azolla* and the developing ovule. Cheaveaud (1892, p. 142) after describing the abaxial ovules in the Asclepiadaceae says: "On admettait jusqu'ici que toutes les Angiospermes produisent leurs ovules sur la face supérieure ou sur la portion marginale de leurs bords carpellaires, et ce caractère constituait l'une des différences invoquées pour séparer le groupe des Angiospermes de celui des Gymnospermes . . . . Or chez la plupart des Cryptogames vasculaires, les sporanges sont situés à la face inférieure des feuilles; les Angiospermes, par la situation de leurs ovules, se distinguaient donc des deux autres groupes de plantes vasculaires. L'observation précédente montre que cette distinction n'existe pas."

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* *i.e.*, the ovule.

Sporangium Wall.

The unusually massive wall (parietal tissue) of each sporangium is in line with the great size of the flower. Goebel (1887, p. 368) records *Agave americana* with 8 to 12 layers in the wall of the microsporangium; *Doryanthes excelsa* has about 10 to 11; whereas Coulter and Chamberlain (1903, p. 34) regard 3 to 5 as the usual number. It has already been shown that there is a little uncertainty as to the morphological unity of the apparent microsporangial wall on account of its zonation and undiscovered initial. Fullmer (1899, p. 82) in *Hemerocallis fulva* describes the primary "tapetal" (parietal) cell dividing to ". . . . a wall layer and an inner layer. The inner layer divides once, forming an intermediate or middle layer, and the layer which develops into the peripheral part of the tapetum." Mascré (1919*a*, p. 1120), in *Datura arborea*, describes the primary parietal layer giving rise to an outer layer and the tapetal layer, the outer layer giving rise in its turn to the transitory layer and the parietal layers ("assises . . . . . , transitoire et parietales"). The zonation in the wall of *Doryanthes excelsa* might quite well be a massive counterpart of the zonation described by the two observers just referred to, particularly in view of Mascré's statement that, by the time the pollen grain acquires an exine, the transitory layer has disappeared; as has the zone t_3 in Text-figures 10 to 15. In *Doryanthes excelsa* the amplification of the parietal tissue accompanies that of the sporogenous tissue, the usual occurrence according to Coulter and Chamberlain (1903, p. 38); but in *Hemerocallis fulva* (Fullmer, 1899, p. 82) it does not develop till the "sporogenous cells are enlarging".

The wall of the megasporangium is massive, and with its radiate appearance simulates the tissue developed from the several-celled primary parietal layer in the Rosaceae. In the Monocotyledons the tendency is to suppress the parietal tissue. In other members of the Amaryllidaceae there is marked suppression. Nevins (1927, p. 372) describes *Furcraea* (*Fourcroya*) *andina* (one of the Agavoideae) as having one or two layers. Pace (1913, Plate xiii, fig. 4) figures no parietal layer in *Atamosco* (*Zephyranthes* or *Hebranthes*) *texana*. Church (1916, p. 399) describes no parietal layer in *Cooperia Drummondii*. Stiffler (1925, p. 212) describes a sub-hypodermal mother cell and says that no "tapetal" cell is cut off in *Cyrtanthus parviflorus*. In general, what parietal tissue there is seems usually to be destroyed by the developing sac, though Coulter and Chamberlain (1903, p. 103) record cases where it remains a cap over the embryo sac, as in *D. excelsa*.

Receptacle tissues.

There is no clearly marked receptacle in the anther.

The massive "nucellus" of *Doryanthes excelsa* is primitive compared with the suppression of it to an axial row in the highest orders, as Orchidaceae, Lobeliaceae, Rubiaceae, and Compositae (Coulter and Chamberlain, 1903, p. 58). The thick mucilaginous walls of some cells of the "nucellus" at the base of the sac are not associated with an haustorial development thereof (the usual case), the antipodal pocket remaining quite small. Schürhoff (1926, p. 484) divides the Amaryllidaceae into three groups, those with two, one and no integuments; the first have the normal four megaspores and the other two follow the *Lilium* type. The following members of the Agavoideae have two integuments and four spores, from one of which the embryo sac develops: *Agave clorantha* and *A. attenuata* (Schlimbach,

1924), *Fourcroya cubensis* (Ernst, 1918), *F. altissima* (Schlimbach, 1924), *F. andina* (Nevins, 1927, pp. 371-2). *D. excelsa* also falls into this group.

Dehiscence.

A possible indication of dehiscence connected with the megasporangium is the occurrence of heavy mucilaginous walls at the base of the embryo-sac. These may be vestiges of "transfusion tissue" (*cf.* Jeffrey, 1917, ch. 15).

Jeffrey (1917, ch. 15) regards the endothecium (fibrous layer) of Angiosperm microsporangia (usually limited to the outer parietal layer, Coulter and Chamberlain, 1903, p. 34) as being descended from a massive endothecium connected to the centripetal wood (of Gymnosperms). The connection has disappeared in *D. excelsa*, but little spatial restriction has occurred. There is, however, a restriction in time, the bands of thickening being laid down about the time of division of the microspore nucleus, later than the usual tetrad formation (Coulter and Chamberlain, 1903, p. 38). In *D. excelsa* the stomium lacks precise organization, appearing crude beside the neat, specialized stomium of *Lilium*.

Tapetum.

In spite of the disparity of precision in the origin and organization of the tapetal tissues connected with the two kinds of sporangia in *Doryanthes excelsa*, there is an underlying uniformity, consisting in the formation of two functional zones, the inner of which organizes the food supplied by the disintegration of the outer for the nourishment of the sporogenous tissue. The zones are less clearly distinguishable in the ovule; but in both cases the inner zone is itself used up about the time of the first division in the germination of the spore. Whereas the highly organized tapetum of the microsporangium is of primary sporogenous origin, the tapetal zones for the megasporangium are of receptacle origin only.

In connection with the microsporangium, Coulter and Chamberlain (1903, p. 37) consider the most frequent origin of the tapetum to be from the innermost layer of the parietal tissue. However, they record its origin from the primary sporogenous cells in *Zostera* (Rosenberg, 1901), some Asclepiadaceae (Frye, 1901) and probably in *Ranunculus* (Coulter, 1898) and *Astilbe* (Webb, 1902). Mascré (1919*a*, p. 1120) describes the origin of the tapetum partly from the primary parietal layer and partly from the cells of the connective in *Datura arborea*. In a later communication (1919*b*, p. 1214) he confirms this by describing it in *Datura tatula*, *D. stramonium*, *Solanum dulcamara*, *Hyocyamus*, *Nicotiana* and *Atropa*), and concludes (p. 1215): "Ce ne sont pas, comme on a prétendu, des cellules archesporiales (ou sporogènes) stériles, redevenus végétatives. Leur évolution est bien évidemment déterminée par leur position et leur rôle physiologique." But *D. excelsa* has a definite early sporogenous origin for its tapetum. Schürhoff (1926) regards the tapetum as of early sporogenous origin; he says (p. 239): "Die Staubbeutel stellen Mikrosporangien dar und die sich in ihnen entwiekelnden Pollenkörner sind als Mikrosporen aufzufassen. Durch der Oberfläche parallel gehende Teilungen der auf die Epidermis folgenden Zellschicht wird die Bildung des Pollen bildenden Gewebes eingeleitet. Die inner Lage dieser Zellen liefert nach Abgabe der Tapetenzellen in weiteren Teilungen die Pollenmutterzellen." He proceeds to give evidence from the nuclear phenomena in the tapetum for regarding its cells as primarily sporogenous. The multinucleate condition is described as due to normal mitosis; the previous interpretation of it being due to amitosis was a misinterpretation of later nuclear fusions for this process. Such fusions produce

"syndiploid" or tetraploid nuclei which, in further divisions, show double the normal chromosome number. Bonnet (1912) describes the division of the tapetal nuclei by two successive mitoses into four nuclei, homologized with the four nuclei derived from the mother cell. With this, and further study of the tapetal cytology, he proposes to establish the tapetum as a sterilized product of the primary sporogenous tissue. Such a study has not been carried out with *Doryanthes excelsa*, but the two normal mitotic figures at the same stage in one tapetal cell of Text-figure 11 suggest the findings of Bonnet, as above. Further evidence for this interpretation in *Doryanthes excelsa* is the "exine" developed on the walls of the tapetal cells. Mascré (1919*a*, p. 1121) describes what appears to be a similar phenomenon.

Mascré (1919*a*, 1919*b*) describes the tapetum as receiving supplies in solution, remodelling and temporarily storing them; finally giving them up and degenerating. In the present case, however, the tapetum does not disappear till the microspore nucleus is dividing, so it would appear that there must be some passage of material through it. *Doryanthes excelsa* does not show any periplasmodium (dissolution of the walls of the tapetum producing a multinucleate plasmodium) or marked projection of the tapetum among the young microspores as recorded for some cases by Schürhoff (1926, pp. 240 and 241). Juel (1915) finds the periplasmodium more frequent among the Monocotyledons than among the Dicotyledons. Schürhoff (1924) concludes that the periplasmodium is a late development, as yet not general, and occurring frequently with another advanced state, namely the tri-nucleate pollen grain. Again *Doryanthes excelsa* does not manifest the advanced condition.

SPOROGENESIS.

Description.

MICROSPORE.

Sporogenous tissue.

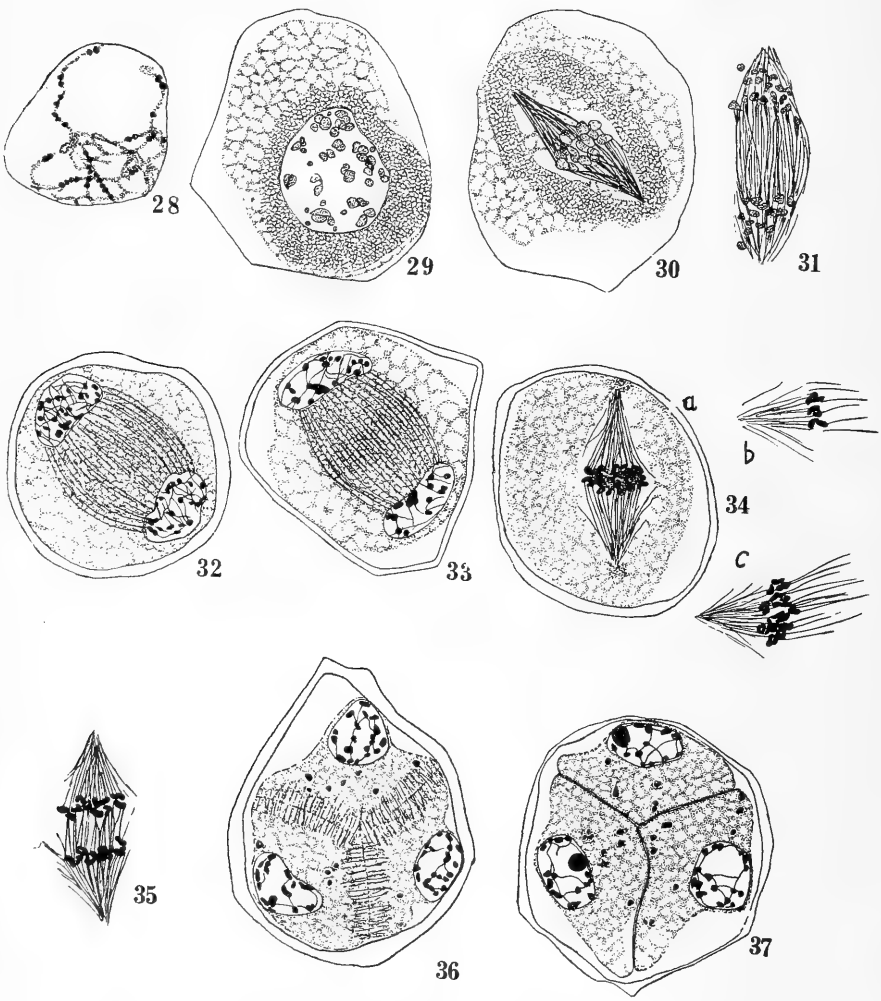
The cells of the young sporogenous groups are typically straight-sided, have large clear nuclei with prominent nucleoli, and dense cytoplasm minutely vacuolate (Text-fig. 9). Each group is uniform in appearance.

Text-figure 10 shows the deeply staining group as having increased from seven to seventeen cells in diameter, and become differentiated into sporogenous and tapetal groups. There are two zones in the sporogenous group, an outer (p_1) whose radially elongated cells have more copious, minutely vacuolate cytoplasm, and an inner (p_2) whose nearly isodiametric cells have scarcer, largely vacuolate cytoplasm. The nuclei of both these sporogenous zones are large and clear, with very prominent nucleoli. The form aspect of this zonation persists somewhat till the early stage of synapsis (Plate xxxiv, fig. 20). This zonation is to be correlated with the disintegration of many of the more central mother cells, due probably to their greater distance from tapetal sources. The disintegration provides a nourishing fluid matrix in which the dividing mother cells float freely (Plate xxxv, fig. 29). This fluid was observed during collection of the material. The typical stage of synapsis is shown in Plate xxxiv, fig. 20.

Reduction Division.

In the formation of chromosomes the usual loop-like processes with chromatin dotted along them (Text-fig. 28), extend across the nuclear cavity (Text-fig. 11) and give rise to the chromosomes opposed in pairs (Text-fig. 29). The uniformly

dense, minutely vacuolate cytoplasm of the synapsis stage has now become zoned, the inner zone staining more deeply and being denser with larger vacuoles (Plate xxxv, fig. 29, Text-figs. 29 and 30). The nuclear membrane disappears and the simple bipolar spindle appears in a lenticular cavity (Text-fig. 30). There is no sign of multipolar origin for the spindle. The egg-shaped chromosomes pass



Text-figs. 28-37.—Stages in the division of the microspore mother cell. Some plasmolysis present. 28: Loosening of the synaptic knot, and disposition of chromatin granules. 29: Paired chomosomes and band of dense cytoplasm. 30: Equatorial plate stage of reduction division. 31: Metaphase of reduction division. 32: End of telophase of reduction division. 33: Evanescent cell plate. 34: Three consecutive sections of the second division, equatorial plate stage. 35: Metaphase of second division. (Spindle not all included longitudinally). 36; Simultaneous wall formation. 37: Young tetrad with dark bodies in cytoplasm. 28, × 985. 29-33, × 960. 34, × 1030. 35, × 1040. 36-37, × 1000.

somewhat irregularly to each pole, where a nuclear membrane is formed and a reticulum begun. An incipient cell plate is not completed and disappears together with the spindle and zonation of the cytoplasm (Text-figs. 31-33). A comparison of the number of chromosomes in Text-fig. 29 (about 40) with that in Text-fig. 31 (two groups of approaching 20 each) shows that a reduction has taken place.

The Second Division.

Without entering into a resting condition, the two free daughter nuclei proceed to the second division. The chromosomes are curved and longer than in meiosis (Text-fig. 34) and pass more regularly to the poles of the spindle.

The spindles are perpendicular to the meiotic spindle, but are at various angles to one another (Text-fig. 34, right angles, and Plate xxxv, fig. 25, parallel and inclined). They are, moreover, independent of one another. The four daughter nuclei invariably take up a tetrahedral position before simultaneous wall formation occurs, shutting off the four spores, each with its complete wall, within the mother cell wall (Text-figs. 36 and 37). Text-figure 12 shows the tetrahedral arrangement without exception; the division is therefore simultaneous.

The young spores (Text-fig. 37) have the cytoplasm as a close network with several deeply staining bodies scattered through it. Nucleoli have formed (*cf.* Text-fig. 36) and a linin network is forming, but the chromosomes are still definite.

The Spores.

The wall of the mother cell soon disappears; the spores maintain their tetrad position for some time (Text-fig. 14 and Plate xxxv, fig. 24), but ultimately become separated. When the exine gains its reticulate thickening (*ep*) the contents of the spore appear to diminish temporarily so that the pore, which occupies one side of the surface, is drawn inwards, giving the spore a wheat-grain appearance (Text-fig. 14). The spore is replenished from the tapetum and the groove is almost obliterated, the mature spore then being about 45 μ long with reticulately thickened exine and single large pore (Plate xxxv, fig. 24). The chromatin is in a light open reticulum—not in a complete resting condition—and the cytoplasm is light with large vacuoles.

MEGASPORE.

Sporogenous Tissue.

The primary sporogenous cell enlarges considerably as it becomes the mother cell (*p*, Text-fig. 20). The early stage of synapsis occurs when the inner integument has reached the top of the sporangium (Text-fig. 22).

Reduction Division.

The lateral net-work ball of synapsis sends across the nuclear cavity, loops (Text-fig. 23) having chromatin dotted along them (Text-fig. 38, *c*). The egg-shaped chromosomes, numbering about 40, are opposed in pairs (Text-figs. 38-40). There are two zones in the cytoplasm, and the only spindle seen was definitely bi-polar. The end of this division was not observed.

In the second division of tetrad formation, there are approaching 20 chromosomes in each group passing towards poles of the spindles (Text-fig. 41); reduction has therefore taken place.

At the end of reduction division a wall is formed (*w*, Plate xxxv, fig. 26). It is clear that the left hand (micropylar) cell is by no means as well developed as the right hand (chalazal) one (see also Text-fig. 41).

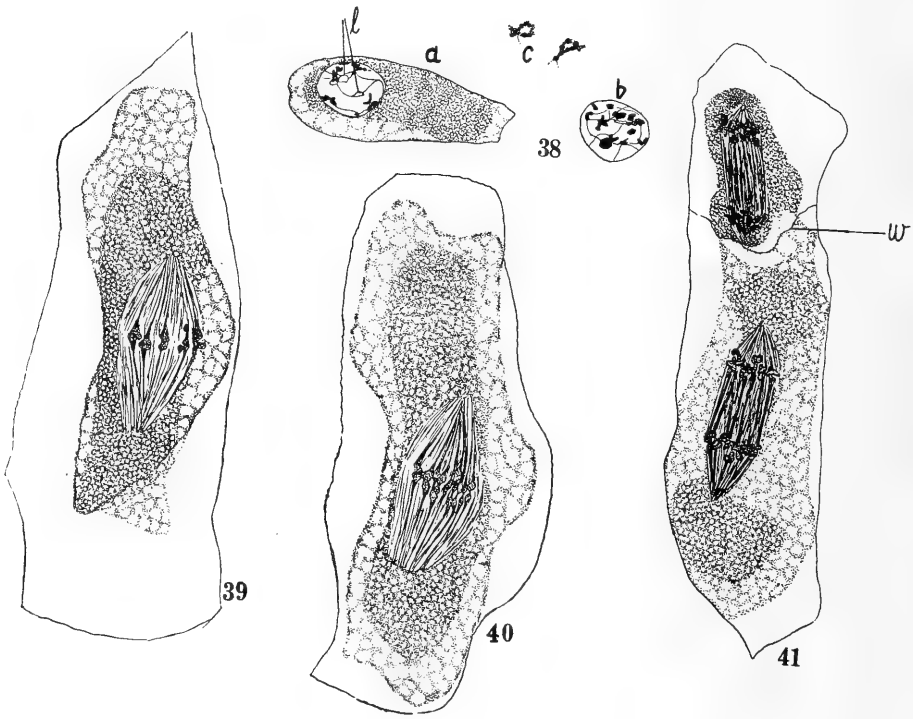
The Second Division.

The second division follows quickly. The micropylar cell, though already beginning to disintegrate, enters upon division (Plate xxxv, fig. 26) and usually completes the process. As with microsporogenesis, the chromosomes in this second division are longer and curved, and the cytoplasm loses most of its zonation.

At the close of the division, walls are formed shutting off the four spores. The spore formation is of the successive type.

Spores.

Of the four young spores (Text-fig. 42) the two micropylar ones (p_3 and p_4) are always insignificant and much disintegrated; the two chalazal ones are larger.



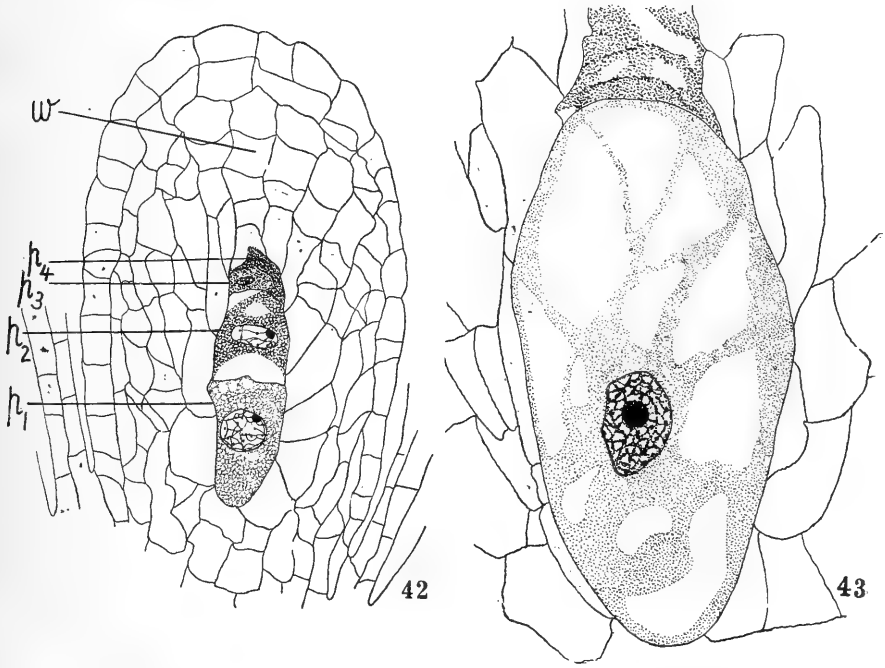
Text-figs. 38-41.—Stages in the division of the megaspore mother cell. Some plasmolysis present. 38: *a* and *b*, consecutive sections showing the chromosomes in pairs with zonation of the cytoplasm; *c*, two retarded chromatin loops (l, in *a*) showing disposition of the granules. 39-40; Consecutive sections showing the equatorial plate stage of reduction division. 41: Metaphase of the second division; *w*, wall formed after first division. 38, *a*, *b*, × 450; *c*, × 975; 39-40, × 965; 41, × 1005.

The upper of these chalazal spores is smaller and already showing evidence of disintegration; whereas the lower one is healthy and turgid. The functional spore comes to maturity (Text-fig. 43) at the expense of the three upper (micropylar) spores. Its cytoplasm is plentiful but largely vacuolate with massive strands supporting the nucleus in the central region. The chromatin of the nucleus appears to attain to a resting condition as a fine network.

Discussion.

Homologies.

The term spore has been used here to denote each of the four uni-nucleate products of tetrad division. The term "pollen" is reserved for the partially germinated microspore that is shed. The term "embryo-sac" is employed directly the megaspore nucleus divides, development proceeding through the two-, four-, and eight-nucleate stages. Such a terminology seems to be more consistent with the implied homologies, than to call the embryo-sac and completed pollen, "spores", for, though the gametophyte truly begins with the reduced number of chromosomes in reduction division (Coulter and Chamberlain, 1903, pp. 41-42), the spore, being the first reasonably definitive element in the gametophyte, is more suitable for description as generated by a sporophytic element than is any product of its own further development.



Text-figs. 42-43.—The megaspores. 42: Showing the megasporangium and part of the nucellus; p_{1-4}, the spores; *w*, the wall of the sporangium. 43: The functional spore with resting nucleus; crushed spores at the top. 42, × 450; 43, × 975.

Rutgers (1923, pp. 15 and 16 and fig. 1*b*), discussing the morphology of the embryo-sac structures as affected by the suppression of divisions in the megaspore mother cell, records Ernst's (1908*a* and 1908*b*) division of the production of the sac into two processes: Embryo-sac formation and embryo-sac development. The end of the first process corresponds to the organization of the functional spore. Such a distinction of processes agrees with the selection of the spore as the point at which to break off the account.

Schürhoff (1926, pp. 244 and 247) and Campbell (1918, p. 603) homologize the spores of the Angiosperms with those of the heterosporous Pteridophytes. For the facilitation of this the terminology of this paper has been arranged. But, according to the views expressed in the present paper, if the pollen is more than uni-nucleate when shed, the microspore has begun to germinate before shedding, and therefore the microspore as well as the megaspore is retained, at least partially.

The Sporogenous Tissue.

Two or three divisions usually occur between the primary sporogenous and microspore mother cells (Coulter and Chamberlain, 1903, p. 38), but in conformity with its large size, *D. excelsa* shows five or more (Text-fig. 8 and Plate xxxiv, fig. 20). The hypodermal archemegasporium, producing primary sporogenous and primary parietal cells with the functioning of the primary sporogenous cell as mother cell, is typical. Stiffler (1925, p. 212), in *Cyrtanthus parviflorus*, describes a megaspore mother cell which is sub-hypodermal, yet states that no "tapetal" cell is cut off. Is the hypodermal layer in that case derived from a primary parietal cell, cut off together with the "mother cell" from a hypodermal archesporium? In other members of the Amaryllidaceae, such as *Atamosco texana* (Pace, 1913, p. 377) and *Cooperia Drummondii* (Church, 1916), the hypodermal archesporium functions as mother cell, a condition advanced over that of *Doryanthes excelsa*.

The process of synapsis in *D. excelsa* suggests the findings of Lawson (1911) who describes the nuclear membrane being distended by great osmotic pressure in the karyolymph, so that the chromatin ball is left in the centre or to the side, according as the distension varies between uni- and equilateral. Schaffner (1909, pp. 201 and 202), on the contrary, after studying living material of the Amaryllidaceous *Agave Virginica*, concluded that synapsis is an artifact.

Reduction Division.

In *Doryanthes excelsa*, the dark-staining zone of cytoplasm round the reduction spindle is a sure means of distinguishing it from a spindle of the second division. Lloyd (1902, pp. 71, 72) describes such a zonation in the cytoplasm of the Rubiaceae. Fullmer (1899, p. 81), in recording a similar occurrence in *Hemerocallis fulva*, suggests that it is an artifact due to the chromic acid in the killing solution. In *Agave Virginica*, Schaffner (1909, Figs. 48, 52, 56, 57, 59) depicts a slightly dark zone in a similar situation, at the anaphase in some cases, but not during the metaphase, when there is sometimes a slightly darker zone at the poles only (Figs. 76, 77, 81). The figures in both Schaffner's paper and this paper are of preparations from material killed with chrom-acetic acid solutions. There would seem, therefore, to be support for the suggestion that the phenomenon is an artifact.

The spindle of *Doryanthes excelsa* is bi-polar from the beginning, as is that in the microspore mother cell of *Agave Virginica*, described by Schaffner (1909, p. 206) who regards multipolar spindles as artifacts caused by mutilations during sectioning. Fullmer (1899, p. 82) describes spindles bi-polar from their inception in *Hemerocallis fulva*.

Doryanthes excelsa is to be added to Schürhoff's (1926, p. 485) record of *Ixiolirion montanum* (Stenar, 1925) as the only member of the Amaryllidaceae to have the simultaneous type of microspore development. Since simultaneous division is characteristic of Dicotyledons, and successive of Monocotyledons, *Doryanthes excelsa* must be considered primitive in this respect.

The megaspore formation is of the successive type, but, by the inequality of the daughter cells of the reduction division, is seen to be tending to the *Lilium* type where the mother cell functions as the spore. Nevins (1927, p. 372) describes successive division for *Furcraea andina*, a closely related species; but the *Lilium* type is recorded for several members of the Amaryllidaceae: *Cyrtanthus parviflorus* (Stiffler, 1925, p. 212), *Atamosco texana* (Pace, 1913), *Cooperia Drummondii* (Church, 1916), *Narcissus* (Guignard, 1882).

Second Division.

It seems that in true simultaneous tetrahedral division the second division spindles should be at right angles. The presence of parallel spindles in this division, and an evanescent cell plate in reduction division of microsporogenesis indicate a trend towards the successive division more characteristic of the Monocotyledons. Fullmer (1899, p. 82) reports the spindles in *Hemerocallis fulva* to be mostly parallel, but occasionally oblique. In his figures the four daughter nuclei appear to be in a plane, but with simultaneous wall formation. This would represent a further stage towards successive division.

The tendency shown by *D. excelsa* to suppress the divisions in megasporogenesis is carried a step further by two other Amaryllidaceae: *Galanthus nivalis* (Stenar, 1925) has the division of the micropylar daughter cell suppressed, whereas *Pancratium maritimum* (Shadowsky, 1925) has the chalazal one suppressed; in both cases the chalazal element functions as the spore. If such a progress towards the *Lilium* type of embryo-sac formation is evolutionary advance, then the Agavoideae group of the Amaryllidaceae is, so far as described, of the more primitive type.

The Spore.

The single pore in the microspore is Monocotyledonous. But the sculptured exine is a Dicotyledonous characteristic (Coulter and Chamberlain, 1903, p. 131); and therefore might be regarded as a primitive feature in a Monocotyledon. The deeply staining bodies in the very young microspores suggest wandering chromosomes or karyomeres. Lary de la Tour (1908, pp. 835 and 836) describes similar bodies giving rise to supernumerary nuclei in the nearly related *Agave attenuata*. Though a slight irregularity in the "drill" of the chromosomes in the second division of the mother cell suggests an origin of these bodies, their organization as supernumerary nuclei has not been observed in *Doryanthes excelsa*.

The functioning of the innermost megaspore is normal. But in the nearly related *Furcraea andina*, the micropylar spore functions (Nevins, 1927, p. 373).

CHROMOSOME NUMBER.

A brief examination of the chromosomes during the reduction and second divisions for both spores indicates a number approximating 20 haploid and 40 diploid chromosomes. This is seen best in Text-figs. 29, 31, 34, 38, 39, 40, 41. Other confirmatory accounts have been made in the case of microsporogenesis. In one division of a microspore nucleus there were 20 pairs of haploid chromosomes ranged around the equator of the spindle. In several vegetative nuclei in the ovule, approaching 40 diploid chromosomes were counted. I would say that there is a reasonable probability that the number for *Doryanthes excelsa* is between 18 and 22 haploid chromosomes.

CHRONOLOGY AND SYNCHRONOLOGY.

GENERAL.

No very precise statements can be made in regard to the seasons (chronology) of development. The flowering stems are produced over a period of two or three months, and the inflorescences each take a number of weeks to expand their full complement of flowers. Thus, in one inflorescence examined on 14th September, 1927, there were 156 flowers ranging from about 0·5 centimetres long to those whose perianth had fallen, i.e. from before organization of an archemicrosporium or of the ovule primordia to fertilization. The relative times (synchronology) for the stages of development in any one flower can be ascertained with reasonable accuracy.

CHRONOLOGY.

The flowering stems for the 1928 season appear in late November and in December of 1927, though some still make their appearance during the early months of 1928. The first flower buds begin to form at the tip of the stem in late February and early March. The archesporial stage in the anther is probably first formed in March; it has been collected at the end of June, and has been found, just beginning to wither, in September. The first microspore mother cells attain synapsis early in April, by which time the primary megasporogenous cell can be identified. Even these dates are probably late, as the largest flower so far referred to would be three centimetres long, whereas flowers 17 centimetres long with complete embryo sacs and mature pollen were collected on 26th May, 1927, and others at about the time of fertilization on 4th July of the same year. In contrast, microspore reduction was collected on 26th November, 1926. It appears, therefore, that any stage can be collected over a period of about five months, and that reduction is occurring during the whole of the winter. By collecting from traumatic flowers, it is possible to obtain a wide range of stages even in January, at the end of the season.

SYNCHRONOLOGY.

The synchronology will be presented in a table. From the preceding section it will be clear that time units can not be used. The time periods will be represented by periods of growth in length. The length of the flower is measured from the insertion of its pedicel on the axis. The left hand column gives the terminal length for each period. The lines of development are correlated as organogeny, microsporogenesis and megasporogenesis.

Table of Synchronology.

The stage of the archesporium is in *italics*, that of synapsis is in SMALL CAPITALS.

Max. approx. length of flower in cm.	Organogeny.	Microsporogenesis.	Megasporogenesis.
0·02	First sign of outer perianth. Pl. xxxiii, figs. 10, 11.		
0·1	First sign of outer stamens. Pl. xxxiii, figs. 10, 11.		
0·13	First sign of carpels. Text-fig. 2, flower 4. Carpels occur between Sections 68 and 83.		
0·3	Carpels closing into the centre; fusion of meristematic zones. Pl. xxxiii, figs. 12, 13.	General grouping of cells under anther lobes. Pl. xxxiv, fig. 16.	
0·6	Differentiation of stamen into filament and anther.	*Primary sporogenous group first definite, primary parietal three layers.* Pl. xxxiv, figs. 17-19; Text-fig. 8.	
1·2	Carpels taking form as in-rolled sporophylls; perianth-stamen tube definite.	Sporogenous group about 8 × 10 cells; parietal tissue 6 to 7 cells across. Text-fig. 9.	
2·0	Carpel surfaces appressed; anthers growing down over filament. Text-fig. 4.	Differentiation of tapetum and sporogenous groups and their zonation. Text-fig. 10.	First sign of ovule primordia. Text-fig. 5; Plate xxxv, fig. 22.
2·5	Stalked carpel fused at back to perianth-stamen tube. Text-fig. 5.		Placenta definite.
3·0			*Placenta bending. Hypodermal archesporium.* Text-fig. 17.
3·5		SYNAPSIS; INNER PARIETAL ZONE CRUSHED; COLLECTION OF STARCH. Pl. xxxiv, fig. 20.	Primary sporogenous and primary parietal cells. Text-fig. 18.
5·0	Margin of sporophyll well advanced. Text-fig. 24.	Reduction division and tetrad formation; outer tapetum crushed. Pl. xxxv, figs. 25, 29; Text-figs. 11, 12, 28-37.	Inner integ. begins; Megaspore mother cell; placenta curved; first tapetal function. Text-figs. 19-24; Pl. xxxv, fig. 23.
7·5			Outer integ.; periclinal division in parietal layer. Text-fig. 21.

Table of Synchronology.—Continued.

The stage of the archesporium is in *italics*, that of synapsis is in SMALL CAPITALS.

Max. approx. length of flower in cm.	Organogeny.	Microsporogenesis.	Megasporogenesis.
8·5		Microspore: exine thickened, wheat grain shape; fluid matrix; exine on tapetum. Text-figs. 13, 14.	SYNAPSIS; INNER INTEG. LEVEL WITH TOP OF SPORANGIUM; OUTER INTEG. HALF WAY. Text-figs. 23, 25.
9·0			Reduction and second divisions; four spores; inner integ. over sporang.; outer integ. at top. Pl. xxxv, fig. 26; Text-figs. 26, 38-42. See also Text-fig. 27.
10		Microspore filled out, mature. Pl. xxxv, fig. 24.	Functional spore; other three disinteg.; Parietal six layers; Micropyle; outer integ. above sporang. Pl. xxxiv, fig. 21; Text-fig. 43.

CONCLUSION.

Detailed conclusions will be reserved for Part 2 of this paper. Certain general considerations are presented at this stage. The Amaryllidaceae are placed high among the Families of the Monocotyledons; *Doryanthes excelsa* exhibits numerous characters which have been interpreted as primitive; and despite its "epigyny," it even appears in several instances more primitive than the Liliaceae (hypogynous). There are therefore indications that *Doryanthes excelsa* must be placed systematically low among the Amaryllidaceae.

Because of the clearness with which *Doryanthes excelsa* shows some of its primitive features, I have ventured to suggest that some of the terms used in Angiosperm morphology should be reconsidered in the light of the homologies implied by them between phenomena in the Angiosperms and in more primitive phyla. The terminology in this paper was arranged with this end in view. It is in the interpretation of the carpels and ovules that the changes are most noticeable.

SUMMARY.

Doryanthes excelsa belongs to the Agavoideae section of the Amaryllidaceae.

Occurring only on the east coast of Australia, its local distribution is governed by edaphic factors, the boundaries of communities being frequently very sharp.

It has the habit of a large herb with radicle leaves. There is a "forerunner tip" on the leaves (possibly on the perianth and stamens), which is suggested to be a vestigial pneumatophore. The plant is regarded as an "evergreen bulb". The inflorescence is a compound raceme; the flowers are large and numerous.

In the flower the whorls arise acropetally, their members spirally but with alternation in successive whorls. The separate primordia later merge to produce the perianth-stamen tube with the carpels adnate; so that the flower is regarded

as not truly epigynous, nor the gynaecium truly syncarpous. The anther has four sporangia. The character, growth, form and tissues of the carpels clearly reveal them as involute leaf structures, with abaxial ovules. The floral development points to the leafy shoot origin of the flower.

The sporangial structures offer facilities for indicating homologies with organs of more primitive Phyla. In the microsporangium, the deeply sunken origin of the sporogenous tissue without clear formation of a primary parietal cell suggests the sporangium of the Eusporangiate Filicales. The tardy appearance of the extensive fibrous layer is a step towards its restriction. The tapetum of the microsporangium is of sporogenous origin; its details of function and its possession of an "exine" indicate a primitive condition. One exceptional case of two bifurcating sporogenous groups was observed.

In the ovule, only the products of the archesporium—the spores and parietal tissue ("nucellar cap")—are regarded as the sporangium which is sunken in the receptacle ("nucellus"). The parietal tissue is histologically distinct from the nucellus, the massiveness of both tissues being primitive, and unusual for a monocotyledon. Thick-walled cells at the base of the germinating megaspore suggest a vestige of dehiscence. Though of different origin and slightly organized, the tapetal function corresponds physiologically with that of the microsporangium. There are two integuments.

Normal reduction takes place in the development of both spores, the occurrence of a band of deeply staining cytoplasm (recorded by other writers) being probably an artifact, due to chromic acid in the fixing agent. The spindles are bi-polar.

In microspore development, however, the spindles of the second division may be oriented, the daughter nuclei become tetrahedrally placed, and the spores are formed by simultaneous wall development (among the Amaryllidaceae occurring only in *Ixiolirion montanum* and *D. excelsa*). A trend to the successive type (monocotyledonous) can be observed. The single pore is monocotyledonous, the sculptured exine dicotyledonous.

The unicellular megasporogenous tissue functioning as mother cell is primitive beside the condition in some other Amaryllidaceae. Megaspore formation is by successive division; but by the weakness of the micropylar product of reduction division is seen to be tending to the *Lilium* type. The inner megaspore functions. The term "spore" is restricted to each of the four uninucleate products of tetrad division, so that not only is the megaspore retained, but also the microspore. The division of the spore at this point is in line with Ernst's division of embryo-sac production into "formation" and "development".

The haploid number of chromosomes is between 18 and 22.

The time during which flowering occurs is very extended. Any one stage can be collected over a period of five months. The critical period of reduction is occurring all through the winter. Synchronology is presented in a table.

In general, *Doryanthes excelsa* is primitive among the Amaryllidaceae. Certain of the appearances in it have suggested changes in the terminology of the flower and of spore production.

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Mr. C. E. Boden, B.Sc., B.Sc.N.A., and Mr. H. G. Gooch prepared many of the photographs and photomicrographs reproduced in this paper.

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* Cited on the authority of Coulter and Chamberlain, 1903.
† Cited on the authority of Schürhoff, 1926.
‡ Cited on the authority of Rutgers, 1923.

EXPLANATION OF PLATES XXXII-XXXV.

Plate xxxii.

1. Railway clearing one mile south of Waterfall Station, showing habit. Inflorescences not fully expanded.
2. Southern gully near Menai showing profusion of *Doryanthes* in the *Eucalyptus* forest. No flowering; at the time of profuse flowering at Waterfall.
3. General view of inflorescence. Lower flowers expanded, upper still closed Subtending bracts are discernible. About $^1/_{15}$ natural size.
4. Part of an inflorescence, showing details of flower. *t*, tip on perianth; *st*, stigma; *n*, nectar. About $\frac{1}{4}$ natural size.
5. Young "forerunner tip" at the apex of the leaf. Diagonal line at end of lamina. $\frac{1}{2}$ natural size.
6. "Forerunner tip", withering; end of the leaf also withering. Diagonal line at end of lamina. $\frac{1}{2}$ natural size.
7. "Forerunner tip" and end of leaf withered. Diagonal line at end of lamina. $\frac{1}{2}$ natural size.
8. Stem bearing "traumatic flowers" after the head has been cut off.

Plate xxxiii.

The model.

A, bract of youngest flower; B, bract of next older flower; C, final minute bract; PS or SP, perianth-stamen tube; *a*, youngest flower; *b*, flower next in age; *c*, carpels; *g*, groove in carpels; p_1, outer perianth; p_2, inner perianth; s_1, outer stamens; s_2, inner stamens; *t*, tip on perianth ("forerunner tip"). The variegation has no significance. Magnifications are of the original apex.

9. General view. Two young flowers to either side with bracts trimmed away, and in the centre two bracts enclosing younger flowers. × 12·5 (horizontal), × 15 (vertical).
10 and 11.—Two youngest flowers and bracts (central portion) cut through and opened out, L.S. × 14 (horizontal) and × 17 (vertical).
12. and 13. Oldest flower (left hand portion) cut through L.S. × 17·5 (horizontal) and × 21 (vertical).
14. and 15. Next younger flower (right hand portion) cut through L.S. × 21 (horizontal) and × 25 (vertical).

Plate xxxiv.

16. Transverse section of a young anther. No archesporium showing. × 180.
17. Transverse section of a slightly older stage of the anther. Two lobes of each of two anthers shown with a vague grouping of cells and density of cytoplasm under each lobe. × 200.
18. Part of a longitudinal section of one lobe of an anther with the early sporogenous group organized about three layers below the epidermis. *w*, wall of the sporangium. × 180.
19. Transverse section of part of two anthers, showing the early sporogenous groups at the same age as that shown in fig. 18. *w*, wall of sporangium. × 180.
20. One microsporangium, early synapsis stage. Zonation of sporogenous tissue shown. t_1 and t_2, inner and outer tapetum. Starch is present in the wall. Transverse section. × 120.
21. At the time of the functional megaspore; showing flow of tissue into margin (S) of carpel rather than into the funiculus (*f*). C, chalaza; *w*, sporangium wall; *n*, "nucellus". T.S. gynoecium. × 90.

Plate xxxv.

22. Photomicrograph of another section of the transverse series selected for Text-fig. 5. Showing tissue differences and epidermes of the carpels which appear as involute leaves adnate to the perianth stamen tube. × 6·5.
23. Photomicrograph of part of a transverse section of an ovary showing that the tissue difference between carpel and perianth-stamen tube encloses the midrib of the carpel. Six double lines of carpel epidermis are shown radiating from the central region. The young ovules are at the same stage as that of Text-fig. 19. The right hand placenta (nucellus) contains a primary sporogenous cell. *e.p.*, two of the epidermis lines; N, placenta (nucellus); S, margin of carpel; *v*, midrib of carpel; W, approximate limit of carpel tissue. × 36.
24. Part of loculus in anther showing mature microspores with exine formed (reticulate) and the tapetum with its "exine". *ep*, exine on microspores; *et*, "exine" on tapetum; P, pore of microspore; t_1, inner tapetum. T.S. × 240.
25. Part of a loculus of the anther showing parallel and oblique orientation of spindles in the second division of the mother cells. t_1, t_2, inner and outer tapetum. L.S. × 240.
26. Second division in the megaspore mother cell showing the wall (*w*) between the two first daughter cells. (Micropyle to the left). × 480.
27. Part of the ovule showing the sunken megasporangium after the functional spore has germinated. *b*, beak on wall of sporangium; *c*, chalaza; *m*, thick-walled cells at base of the sac; *n*, base of the "nucellus"; *t*, crushed "nucellar" cells; *w*, wall of the sunken sporangium. T.S. gynoecium. × 120.
28. Showing the thick walls of the cells of the placenta (nucellus) at the base of the embryo-sac. *m*, thick wall. T.S. of the gynoecium. × 360.
29. Loculus of the anther showing various stages of reduction division, the zonation of cytoplasm and the thick walls of the mother cells. The mother cells towards the left (place of dehiscence) are more advanced. The inner tapetum has broken away from the outer tapetum. t_1, inner; t_2, outer tapetum; T.S. × 120.

NEW AUSTRALIAN MYDAIDAE (DIPTERA).

By I. M. Mackerras, B.Sc., M.B., Ch.M.

[Read 31st October, 1928.]

Since the review of this family by Mr. G. H. Hardy (These Proceedings, 1, 1925, 139-144), five new species have come to hand and I present here descriptions of these, together with a key to the Australian species of the family and notes on additional synonymy based on information received by Mr. Hardy from Major E. E. Austen, of the British Museum. Nearly all the material before me comes from the Macleay Museum, University of Sydney, and the types of the new species will be lodged in that Institution. It has been possible to recognize all the known species, with the exception of *Miltinus sordidus* Westw. I am indebted to Mr. A. Musgrave of the Australian Museum for material assistance in elucidating the problems presented by some of the older descriptions.

The wing venation of the Mydaidae is rather complex and is interesting in that the disposition of the branches of media is practically identical with that of the Nemestrinidae. The "oblique vein" is present and, but for the uniform presence of r-m, has practically the same constitution; it is, however, more irregular and more transverse in position. The media of *Trichophthalma* and *Nycterimyia* figured in a previous paper (These Proceedings, 1, 1925, fig. 3*a*, p. 495, and fig. 15*b*, p. 553) corresponds very well with that of *Diochlistus* and *Miltinus* respectively. While this resemblance is striking, it cannot, I think, be used for phylogenetic purposes unless supported by other structural similarities.

The length of the antennae (principally of that part composed of the elongate third segment) offers a useful character for subdivision within the genera. These groups appear on other grounds to be natural ones and the distinction between species with long antennae and those with short antennae is sharply defined in both genera, with the single exception of *Miltinus maculipennis* Westw., which is intermediate in structure, although apparently to be allied with the species with short antennae, to which group *M. dentipennis*, n. sp., also belongs.

Key to the Species.

1. M_1 and M_2 separate, i.e. two veins reaching the wing margin between R_5 and the apex ..... Genus *Diochlistus* 2
   M_1 and M_2 fused, i.e. one vein reaching the wing margin between R_5 and the apex ..... Genus *Miltinus* 6
2. Antennae markedly elongate, third segment at least five times the length of the first and second together 3
   Antennae much shorter, third segment but little longer than the first and second together 5
3. Wings mostly bright orange, opaque; abdomen orange with indefinite transverse black markings towards the base ..... *D. auripennis* Westw.
   Wings brownish, transparent; abdomen with alternating black and lemon-yellow markings 4
4. Face and apical half of hind femora orange to bright brown; robust species ..... *D. melleipennis* Westw.
   Face and apical half of hind femora black; smaller, more slender species ..... *D. gracilis* Macq.

5. Abdomen black, without pale bands; wings deeply suffused with dark brown .... *D. nicholsoni*, n. sp.
   Abdomen grey to black, with conspicuous, narrow, pale yellow fasciae; wings subhyaline ..... *D. mitis* Gerst.
6. Wings with conspicuous dark brown markings 7
   Wings hyaline or more or less infuscated, never with a definite pattern 8
7. Wings hyaline, with pale yellow fore margin and a single large dark brown patch in the centre ..... *M. maculipennis* Westw.
   Wings with the anterior two-thirds dark brown, the posterior margin of the dark colour being irregularly dentate ..... *M. dentipennis*, n. sp.
8. Antennae markedly elongate, third segment more than three times the length of the first and second together; large species 9
   Antennae much shorter, third segment little more than twice the length of the first and second together; small, slender species 13
9. Thorax and abdomen bright orange, the latter with basal and small lateral black markings ..... *M. cardinalis* Gerst.
   Not such species 10
10. Abdomen with large and conspicuous, triangular or rounded, sublateral pale markings on four or more segments 11
    Abdomen with narrow silvery grey basal sublateral or transverse markings on a variable number of segments, never broadened on more than two segments .. 12
11. Scutum entirely black; abdomen with four large, triangular, luteous lateral patches ..... *M. sordidus* Westw.
    Scutum black with conspicuous creamy markings; abdomen with large, rounded, sublateral, creamy patches on all segments ..... *M. musgravei*, n. sp.
12. Abdomen with the apical half or more of the ground colour red, the remainder black ..... *M. stenogaster* Westw.
    Ground colour of the abdomen black, or very dark brown for its entire length .... *M. viduatus* Westw.
13. Abdomen orange, with a narrow dark brown fascia on each segment .... *M. tenuis*, n. sp.
    Abdomen black or dark brown, with small transverse silvery markings on a variable number of segments ..... *M. minutus*, n. sp.

Genus Diochlistus.

Diochlistus melleipennis Westwood.

This species was listed by Hardy as a synonym of *D. gracilis* Macq. Austen (in lit.) pointed out that it differed from that species, a finding which is confirmed by a study of a good series of both sexes of the two forms. *Mydas clavigera* Walker, 1848, and *Mydas effracta* Walker, 1857, are synonyms.

Diochlistus nicholsoni, n. sp.

A black species with short antennae and deeply infuscated wings.

♀. Head black, pale grey dusted around the eyes and on the occiput; hairs rather sparse, black, mixed with some grey behind the vertex and below the antennae. Antennae black, about two and one-half times the antero-posterior diameter of the head; first segment elongate, slender, second small and rounded, third as long as the first and second together, fourth a little longer than the third, broadly spatulate, almost rounded. Proboscis small, projecting but little beyond the oral margin.

Scutum pale grey dusted, with three broad black vittae extending throughout its length giving it a predominantly black appearance. Scutellum black. Pleurae shining black.

Legs black, tarsi brownish-black, knees bright brown. Hind femora slightly incrassate, with two ventral rows of stout bristles on the apical two-thirds.

Wings deeply suffused with dark brown, which is darkest along the veins and sometimes completely fills the cells. The colour extends from the base to a little beyond the tip of R_1 and posteriorly through the bifurcation of M_{1+2} to the tip of

Cu_1. The cubital and anal cells and the distal part of the wing are clear. The cell C is less deeply clouded than the wing below it.

Abdomen elongate conical, black, tomentose, with a narrow zone at the apex, and inconstantly at the base, of each segment bare and shining.

Length: body, 15 mm.; wing, 12 mm.

Holotype ♀ and one paratype ♀, Ooldea, South Australia, 18th Aug., 1926, A. J. Nicholson.

A very distinctive species which is apparently most nearly related to *D. mitis* Gerst. Named in honour of the collector.

Genus Miltinus.

Miltinus stenogaster Westwood.

Midas stenogaster Westwood, *Arcana Entomologica*, i, 1841, p. 53, species xxxi, Pl. 14, fig. 3. Swan River, Australia.—*Midas bicolor* Westwood, *loc. cit.*, p. 53, species xxxii, Pl. 14, fig. 4. Western Australia.

Austen found from an investigation of the types that the above two names applied to the same species, a conclusion at which I had also arrived after studying the series available to me, including a pair taken *in copula*, the male of which agreed very well with the description of *M. stenogaster*, while the female was an undoubted *M. bicolor*.

Miltinus dentipennis, n. sp.

A small, slender species with short antennae and pictured wings.

♀. Head black, somewhat greasy, occiput and parafacialia pale grey dusted, hairs mainly creamy. Antennae brown, about twice as long as the antero-posterior diameter of the head; first and second segments short, the former about twice the length of the latter, third segment slender, about twice the length of the first and second together, fourth segment a little shorter than the third, stoutly pyriform with the narrow end directed basally and with a mammilliform tip. Proboscis about twice the length of the oral aperture.

Scutum dark brown tinged with russet, with the lateral and posterior margins broadly, and the scutellum entirely, bright orange brown. Pleurae shining yellowish-brown.

Legs uniformly bright yellowish-brown. Hind femora moderately incrassate, with two ventral rows of strong spines.

Wings with a dark brown pattern extending the full length of the anterior margin to the tip of M_{1+2} and posteriorly to Cu_1, with slight suffusion of the cubital and anal cells. The hind margin of the coloration is well defined and there is a hyaline indentation between the tips of Cu_1 and M_{3+4} extending into the middle of the discal cell and a second clear area just distal to the composite transverse vein extending forward almost to R_1; the curvature of Cu_1 makes a third indentation. There is a small clearer area in the brown near the tip of the appendix to R_4 and another below and basal to the origin of Rs.

Abdomen elongate, slender, almost parallel-sided, bright yellowish-brown in colour with the basal segment, two or three of the apical segments and a narrow transverse zone at the apex of each of the intervening segments dark brown.

Length: body, 15 mm.; wing, 10 mm.

Holotype ♀, South Australia, without further data, from the collection of the Macleay Museum. A second ♀ in the collection of the Department of Public Health is from Bright, Victoria, H. W. Davey, and is slightly larger, measuring 18·5 mm. This specimen is greasy.

M. dentipennis can be immediately recognized by the wing markings.

MILTINUS MUSGRAVEI, n. sp.

A long bodied, short winged species with long antennae and conspicuous, paired, creamy spots on the abdominal tergites.

♂. Head covered with creamy tomentum except for a small bare black area above the antennae; face prominent, pale yellow; hairing of head and face relatively long and dense, creamy in colour. First segment of antennae short, cylindrical, about three times as long as broad, second segment as long as broad, third segment (in ♀, missing in the ♂) elongate, rather more than three times the length of the first and second together, remainder of the antennae missing but the type obviously corresponds with that of *M. viduatus* Westw. and its allies. Proboscis short, not longer than the oral aperture.

Scutum black, with a series of large, oblong or irregular, dull creamy yellow patches arranged in a ring round the margin. Scutellum inconspicuous, black; post-scutellum dull cream coloured with a narrow median black vitta. Pleurae shining black, with an elongate patch of creamy tomentum below the anterior spiracle.

Legs bright brown; the hind femora are a little darker in colour, strongly incrassate and bear the usual double row of strong ventral spines.

Wings subhyaline, almost clear and without any darker suffusion.

Abdomen elongate, slender, black. Each segment except the first bears a pair of conspicuous, semicircular, dull creamy patches which enlarge progressively posteriorly and become confluent in the mid line on some of the apical segments.

Length: body, 23 mm.; wing, 15 mm.

♀. The only female before me is in poor condition, but appears to differ from the ♂ only in the somewhat duller markings on the abdomen, which is, as usual, broader and more parallel-sided, and in the wings being faintly tinged with brown.

Length: body, 25 mm.; wing, 17 mm.

Holotype ♂, allotype ♀ and one paratype ♂, all labelled South Australia, without further data, from the collection of the Macleay Museum.

The nearest relative of *M. musgravei* appears to be *M. sordidus* Westw., which I have not seen, but which differs in the original description and coloured figure in having an entirely black thorax and only four larger, differently shaped, luteous spots on the abdomen. It is just conceivable, if Westwood's description were based on an extremely greasy specimen, that this may be his species, but I think it is extremely unlikely. Named after Mr. Anthony Musgrave of the Australian Museum.

MILTINUS TENUIS, n. sp.

A very small, slender species with short antennae, hyaline wings, and orange abdomen which is narrowly banded with dark brown.

♀. Head shining black, grey dusted below the antennae and on the occiput; face shining orange yellow; hairs sparse and inconspicuous, grey to creamy in colour. Antennae short, the basal segments short, black, the first about twice as long as the second, third segment brown, about twice as long as the first and second together, fourth segment brown dorsally, bright orange yellow ventrally, about three-fourths the length of the third, broadly pyriform in shape with the narrow end directed basally. Proboscis about twice the length of the oral aperture.

Scutum black with the humeral and post-alar calli bright yellow; there is a pair of pale grey dusted dorsocentral vittae and a broader, paler vitta along each lateral margin. Scutellum dark brown, shining; postscutellum orange yellow, with

a narrow, indefinite, median brown vitta. Pleurae shining brown, orange yellow below the wing root.

Fore and mid legs bright yellow, hind legs more or less deeply tinged with brown; hind femora strongly incrassate.

Wings perfectly clear, without any darkening whatever.

Abdomen slender, parallel-sided, bright orange, with narrow dark brown basal and apical fasciae and lateral vittae to each segment; the bands also tend to be drawn out to form indefinite median vittae, which vary considerably in different specimens, being sometimes almost complete.

Length: body, 14 mm.; wing, 9 mm.

Holotype ♀, South Australia, without further data, from the collection of the Macleay Museum. There are other females, all apparently from the same locality, in the Macleay collection. All these are somewhat rubbed and the scutal ornamentation is consequently not well seen.

A very distinct little species on account of its slender form, clear wings, dark thorax and orange abdomen.

MILTINUS MINUTUS, n. sp.

A small, dark species, with short antennae, silvery grey vittate scutum and narrowly silvery fasciate abdomen.

♂. Head covered with silvery white tomentum contrasting strongly with the dark eyes, hairs white. Antennae dark brown, first and second segments short, the first slightly bulbous, third segment slightly more than twice the length of the first and second together, fourth about two-thirds the length of the third, stoutly pyriform, almost globular in shape. Proboscis about twice the length of the oral aperture.

Scutum dark grey, with a pair of dorsocentral greyish-white vittae which broaden out anteriorly and posteriorly, and with a broader, white dusted vitta along each lateral margin. Scutellum dark grey; post-scutellum dark grey with extensive greyish-white dusting. Pleurae dark brown.

Legs dark brown, hind femora strongly incrassate.

Wings hyaline, without darker suffusion or markings.

Abdomen brownish-black, the basal five segments with narrow silvery white bands which are evanescent in the mid line and broader laterally, where they tend almost to form a pale dusted marginal vitta. The first fascia covers the apex of the first tergite and the base of the second, the remainder are basal in position.

Length: body, 13 mm.; wing, 8 mm.

♀. Differs from the male in being more robust, of brown rather than blackish general coloration, in the wing being distinctly suffused with brown, and in the pale markings of the abdomen being fewer in number (generally three) and distinctly narrower.

Length: body, 14 mm.; wing, 10 mm.

Holotype ♂, Western Australia, Newman, and allotype ♀, South Australia, both without further data, are from the Macleay Museum.

This species might be taken for a very small form of *M. viduatus* Westw., but differs markedly from that species in the structure of the antennae.

REVISION OF *HESTHESIS* (FAM. CERAMBYCIDAE), TOGETHER WITH THE DESCRIPTION OF A NEW GENUS AND SPECIES OF THE BUPRESTIDAE.

By H. J. Carter, B.A., F.E.S.

(One Text-figure.)

[Read 31st October, 1928.]

Hesthesis Newm.

The genus *Hesthesis* contains what are known in Australia as the "wasp" longicorns and these are found commonly on flowers of *Leptospermum*, *Eucalyptus* and *Angophora*. In life their jerky, restless movements, their short elytra and evident wings make their resemblance to some of the Thynnid wasps very remarkable, especially in the females with their shorter antennae. In most species it is curious that the females are much more common than the males. This resemblance is so strongly marked in *H. ferruginea* Boisd. to *Exeirus lateritus* Shuck. that I have in early collecting days had cause to regret a hasty seizure and hastier release of the wasp, while on other occasions allowing the longicorn to go scot free, though a desirable capture. Mr. J. E. Dixon, of Melbourne, a keen entomologist and observer, has bred out *H. cingulata* Kirb., from "mallee" *Eucalyptus* roots, and *H. plorator* Pasc., from the roots of *Leptospermum scoparium*. Indeed it is to the work of this naturalist that I am indebted for determining with certainty the ♂ of *cingulata*, which I found nowhere so labelled in Australian collections,* though sometimes it was confused with *H. moerens* Pasc., which it somewhat resembles except in the shape of its elytra.

So distinct is the genus that it forms a separate subfamily in the Junk Catalogue, edited by Professor Aurivillius. Of the thirteen names included here, *auricoma* Newm., must be transferred to another genus. It was described as *Necydalis auricomus* in the same paper as that in which Newman described the genus *Hesthesis*, giving a list of the three species to be included—*variegata* F., *ferruginea* Boisd., and *cingulata* Kirby—and adding a fourth *H. bizonata*. Its inclusion under *Hesthesis* is doubtless due to the suggestion contained in Lacordaire's note (Lac., T. viii, p. 478). A letter from Mr. K. G. Blair to me, I think, solves the problem. He writes: "There can be little doubt from the description that it" (*Necydalis auricomus* Newm.) "is *Agapete kreusleri* Pasc., and this probability is strengthened by a curious error in White's *Cat. Col. Brit. Mus.*, in which Pl. v, fig. 4 is credited to *A. carissima* Newm. (an error repeated in Aurivillius' Catalogue). From the description of this it differs strongly, also from Saunders' figure in *Trans. Ent. Soc. Lond.*, and it appears probable that the name *A. carissima* Newm., should really have been *A. auricoma* Newm. At any rate, the figure represents *A. kreusleri* and the species is indicated by White as being in the British Museum. Of *A. carissima* White (= *vestita* Pasc.†) we have

* A similar thing is true of *H. ferruginea* Boisd., which in all Australian collections known to me was only represented by females.

† For this synonymy I rely on Newman's description and Saunders' figure compared with Pascoe's type (K. G. Blair).

only Pascoe's specimens which did not come in till 1893. Of *A. kreusleri* Pasc., we have one specimen (no name attached) received in 1853, with the legs and antennae of one side in the position of White's figure and this example was no doubt the original of the figure assigned to *A. carissima* (recte *auricoma* Newm.)."

H. bizonata Newm.—It is unfortunate that neither Saunders nor Pascoe identified Newman's species of which the unique type was said to be "in Mus. Soc. Zool. Lond." I had already concluded by the process of exhaustion that either *vigilans* Pasc. or *ornata* Saund., was synonymous with *bizonata* when I received Mr. Blair's letter noted above, in which he says "*H. bizonata* Newm. We have a single ♀, the only data "New Holl. Vigors Coll. 59.57", that agrees exactly with the description". Here follows a detailed description which clearly indicates *H. ornata* Saund., except for rather darker legs "apical half of femora being black". With this slight variation I have little hesitation in placing *ornata* Saund., as a synonym of *bizonata* Newm.

H. moerens Pasc. = *H. murina* Pasc. — *fide* K. G. Blair, who has sent me an example that has been compared with the types of both. Curiously, all the examples examined, of which 25 are before me, are males. It is a rather common species in the neighbourhood of Sydney. The complete absence of females to match this species is mystifying. Mr. Blair suggests that it is the male of either *plorator* Pasc., or of *cingulata* Kirby. The latter alternative may be ruled out, since I have before me evident males of *cingulata*, in which the elytral hind margin corresponds with that of the females. Similarly I have many of both sexes of *plorator*, chiefly from Victoria and Tasmania where it is common. I have not seen a Sydney example of *plorator* which is readily differentiated from *cingulata* by the spinose sutural hind angle of the elytra. This is not characteristic of *moerens* Pasc., apart from the different ventral bands of these species.

H. vigilans Pasc.—This is also an exception to the rule of prevalence of females. Only three females occur amongst the 25 examples before me.

I have both sexes of all except *moerens*. Thanks to the courtesy of the several Australian Museum authorities I have been able to examine long series of nine of these. The tenth, *H. bizonata* Newm. (= *ornata* Saund.), appears to be rare, five examples only being identified.

Three new species—or subspecies—have been added.

Characters.—The long series available has enabled me to study the variations and distribution of the several species, and to obtain some knowledge of the constant characters that delimit them.

The species vary considerably in size, *ferruginea*, *cingulata* and *angulata* being the largest and *acutipennis*, *montana*, *variegata* and *ornata* the smallest; but in all species the male is generally much smaller than the female. Thus in *ferruginea* an average of eight males gives 18 mm. long; of eight females, 27½ mm.; in *acutipennis*, males range from 10 mm. long, while females measure up to 19 mm. long. Similarly with other species. The males of *cingulata*, *ferruginea* and *vesparia* are generally darker in colour than the females.

The only structural characters by which the species can be separated are (1) the hind margins of the elytra and (2) to a much less extent, the sides of prothorax. This latter character is apt to be illusive, the sides being more often subangulately widened than as stated by authors, *acutipennis*, *montana*, *variegata*, *ornata*, *vigilans* and *crabroides* often—though not invariably—showing a decided angulation. In the other species the sides are variably, but more or less strongly, rounded.

The hind margins of elytra are thus the most defined of the structural characters, and the species fall into two fairly well distinguished groups on this alone,

(*a*) having hind margins obliquely divergent—*angulata*, *cingulata*, *assimilis*, *plorator*, *montana*, *ferruginea* and *acutipennis*, the last very slightly and variably.*

(*b*) hind margins more or less truncate—the remaining species.

The number, colour and arrangement of the pale pubescent bands on the abdomen are subject to little variation in the same species, with a few exceptions. These abdominal bands vary with the species, both in the case of the dorsal and ventral bands, but are generally constant in the same species. These bands are not true zones, that is, are not carried round the body, except the one, or two, near apex.

Thus in *ferruginea*, *acutipennis* and *montana* the bands on the fourth and fifth dorsal segments are continuous with the third and fourth ventral. In *cingulata*, *plorator* and *vigilans* the dorsal fourth segmental band is continuous with the ventral third; the bands near the dorsal base not corresponding with ventral bands.

These bands are in general as follows:—

Dorsal	Ventral	
2	1	*moerens* Pasc.
2	2	*bizonata* Newm., *vigilans* Pasc., *crabroides*, n. sp.
2	3	*angulata* Pasc., *cingulata* Kirb., *plorator* Pasc.
3	2	*variegata* F.
3	4	*acutipennis* Pasc.
3–5	4	*montana*, n. sp.
4	3 or 4	*assimilis*, n. sp., *vesparia* Pasc.
4	4	*ferruginea* Boisd.

To which the following variations occur:—

cingulata. In the male the ventral bands beyond the basal are variably, often feebly, marked (very much as in *moerens*), but are otherwise inseparable from others normally banded. In rare cases—two females from Armidale, N.S.W., in the Macleay Museum and one in the National Museum labelled Plenty Ranges—I find Var. I, in which two or three dorsal bands occur at the base, and the ventral bands tend to a yellow colour. Var. II is a small female in the Macleay Museum, 15 mm. long, from Sydney, without any dorsal subapical band, but with two dorsal basal bands.

Distribution.

angulata	W.A. (King George's Sound).
cingulata	Vict., Tas., N.S.W. (1 ♂ in Macleay Mus. labelled King George Sound).
assimilis	Clarence River, N.S.W., also Swan River (?) (in Macleay Mus.).
plorator	Vict., Tas., S. Aust.
montana	N.S.W., Mt. Kosciusko.
acutipennis	Q'ld., N.S.W. (1 example labelled Melbourne).
variegata	N.S.W. and S. Aust. (1 example labelled Beverley, W.A., in S. Aust. Mus.).

* "The type" (of *acutipennis*) "is abnormal, having the left elytron as described, the right truncate". (*fide* K. G. Blair). With a very long series before me I find examples with more variation of elytral hind margins than in other species; in general very lightly oblique with a tendency to spinose extension at the suture.

bizonata	N.S.W.
moerens	N.S.W.
ferruginea	N.S.W.
crabroides	Stanthorpe, S. Q'ld.
vesparia	Rockhampton, Port Denison, Dawson River, N. Q'ld.

The following species are new, or, if subspecies only, deserve description and a name.

HESTHESIS CRABROIDES, n. sp.

Black with brilliant orange markings; elytra castaneous with a wide orange band bordering the anterior, interior and posterior area and occupying the greater part. The other orange markings as follows: front of head extensively, pronotum, apical ring and isolated parts of base, metasternum, a medial and two (sometimes three) lateral spots; abdomen above with two orange bands, below with two bands, in the male basal band white, on third segment orange, in female both orange; the apical segment wholly yellow, antennae and legs orange. *Prothorax* subangulate at sides, *elytra* subtruncate at apex, with sutural angles slightly dentate, especially in the male.

Dim.—♂. 13 mm. long; ♀. 15-22 mm. long.

Hab.—S. Queensland: Stanthorpe (Mr. E. Sutton).

I am indebted to a local naturalist and keen observer, Mr. Sutton, for a long series (2 ♂, 14 ♀) of this species. At first I was inclined to consider it as a subspecies of *H. vigilans* Pasc., but after a close comparison with long series of *H. variegata* F., and of *H. vigilans* Pasc., I note the following constant differences, amidst numerous variable characters, that are best exhibited in a tabular form:—

variegata F.	*vigilans* Pasc.	*crabroides*, n. sp.
Antennae. Dark brown, basal segments reddish.	as in *variegata*	orange
Elytra. Brown or black, apex and base slightly yellow.	as in *variegata*, more yellow.	widely orange
Abdomen. Apical segment dark.	dark	red or yellow
pale zones, 3 above, 2 below (basal white, subapical red).	2 above, 2 below (both red).	2 above, 2 below ♂ as in *variegata* ♀ as in *vigilans*

Holotype and allotype in Coll. Carter.

HESTHESIS ASSIMILIS, n. sp. or subsp.

Tawny brown; front of head, basal and apical bands of pronotum, wide horseshoe band of elytra, margins of metasternal episterna bright yellow; abdomen with four bands below and four bands above (two at base, two near apex) also yellow; antennae brown, femora (and sometimes tibiae) reddish.

♂. Head with vertex brownish-black, whole face clothed with yellow hair; *prothorax* nearly black, a medial carina on apical half, sides well and regularly rounded. *Elytra* less sharply diverging behind than in male of *cingulata* K. (also than in the female examples of *assimilis*), otherwise similar in form to *cingulata* Kirby, a narrow external area only a tawny brown, the greater part occupied by arcuate flavous band.

♀. Differs in larger size, pronotum largely clothed with yellow hair, the hind margins of elytra strongly oblique and angulate externally. Abdomen with three bands at base and four (sometimes five) bands below a clear yellow.

Dim.—♂. 17 mm.; ♀. 23-25 mm. long.

Hab.—N.S.W.: Clarence River; W. Aust.: Swan River (in Macleay Museum).

Two examples (1 ♂, 1 ♀) labelled Clarence R., a ♀ labelled N.S.W. and 2 ♀ labelled Swan R., are specifically inseparable, and suggest a subspecies of *cingulata* Kirby, of which the range is similarly wide. But in the long series examined, about fifty examples, of *cingulata*, I find the upper abdominal bands to consist of two only (with rare exceptions noted above), while the black and white of the typical *cingulata* is here replaced by brown and bright yellow respectively.

Holotype and allotype in the Macleay Museum.

Hesthesis montana, n. sp.

Black; front with minute spot (sometimes wanting), prothorax with more or less complete apical band, and sometimes with parts of a basal band, a small transverse mark on apex of elytra, two spots (at apex and base respectively) of metasternal episterna pale yellow or white; segments of abdomen with (at least) three above—one on first, others on fourth and fifth margins—and four below pale yellow or white; elytra dark castaneous, their exterior margins black. Antennae dark red, legs a brighter red, knees black; abdomen black.

Head and *prothorax* very similar to those of *acutipennis* Pasc. *Elytra* with hind margins obliquely divergent as in *cingulata* Kirby, but their sutural angle slightly produced, forming an obtuse angle, the exterior angle rounded off at the extremity.

Dim.—♂. 11-16 mm. long; ♀. 16-20 mm. long.

Hab.—N.S.W.: Mt. Kosciusko (Professor L. Harrison, Mr. A. J. Nicholson and the author).

Forty-seven examples before me show a small, narrow species very near to *H. acutipennis* Pasc., but separated by the much greater obliquity of the hind margins of the elytra. *H. plorator* Pasc. (of which a long series is before me) is separated by the constant occurrence of two pale dorsal zones and three ventral on the abdomen; the coloration is more suggestive of *plorator* and *cingulata*, the ground colour being everywhere black except on elytra. In some examples as many as five dorsal bands can be made out on abdomen.

Holotype and allotypes in the Macleay Museum.

Table of Hesthesis.

1.	Apical segment of abdomen dark	2
	Apical segment of abdomen yellow or red	11
2.	Elytra obliquely divergent behind	3
	Elytra more or less truncate behind	8
3.	Elytra diverging from about half way	*angulata* Pasc.
	Elytra diverging behind half way	4
4.	Pale bands of abdomen, two dorsal, three ventral	5
	Pale bands of abdomen otherwise	6
5.	Sutural hind angle of elytra produced (dentate)	*plorator* Pasc.
	Sutural hind angle of elytra not produced	*cingulata* Kirby
6.	Sides of prothorax subangulate	7
	Sides of prothorax evenly rounded	*assimilis*, n. sp.
7.	Elytral margins strongly oblique, abdomen black, bands white	*montana*, n. sp.
	Elytral margins less strongly oblique, abdomen brown, bands orange	*acutipennis* Pasc.
8.	Abdomen with one defined ventral band, colour dingy	*moerens* Pasc.
	Abdomen with two defined ventral bands, colours brighter	9
9.	Abdomen with three defined dorsal bands	*variegata* F.
	Abdomen with two defined dorsal bands	10
10.	Ventral bands orange	*vigilans* Pasc.
	Ventral bands white	*bizonata* Newm.

11. Elytra obliquely diverging behind ..... *ferruginea* Boisd.
Elytra more or less truncate behind 12
12. Abdominal bands, two dorsal, two ventral ..... *crabroides*, n. sp.
Abdominal bands, four dorsal, three or four ventral ..... *vesparia* Pasc.

Synonymy. *H. bizonata* Newm. = *ornata* Saund.

H. moerens Pasc. = *murina* Pasc.

Further evidence may show *bizonata*, *vigilans* and *crabroides* to have subspecific value only. At present I think they are sufficiently differentiated to be considered distinct.

Epania australis, n. sp.

♀. Black nitid; head and prothorax black, with slight tendency to metallic sheen, the latter bordered castaneous at apex and base, elytra rufo-testaceous, antennae dull brown, the two basal segments castaneous, anterior and intermediate legs flavous, apices of mid-tibiae and their tarsi dark, posterior legs metallic black, abdomen with short white lateral pubescent band on each side, not connected below, a slight similar pubescence of metasternal episterna.

Head finely and closely punctate, antennae extending beyond the apex of elytra, their segments subequal (except the short second). *Prothorax* elongate-ovate, convex, contracted and finely pubescent within the apical and basal borders; densely cellulose-punctate with short, upright pile. *Scutellum* pubescent. *Elytra* dehiscent from about half way, rounded behind, rather closely punctate with short, upright, white hairs; wings not as long as body, iridescent; legs very hairy.

♂ wanting.

Dim.—9 × 2 mm.

Hab.—N. Queensland: Cairns and Kuranda (F. P. Dodd).

Two examples, both ♀, are in the South Australian Museum with the generic determination by Mr. A. M. Lea. They correspond very closely with Pascoe's figure of *E. discolor* (*Trans. Ent. Soc. Lond.*, 1869, pl. xxi, f. 7), but the apices of elytra are not "tinged with chalybeate", the posterior legs show colour differences, and there is no mention by Pascoe of the lateral pubescence on the abdomen and metasternum, so evident in *E. australis*. Holotype in South Australian Museum.

N.B.—A second species has been sent from the British Museum, amongst some *Hesthesis*, that was taken by Mr. G. F. Bryant at Kuranda, but the antennae and two legs are wanting so that it is unsuitable for description.

The above adds another genus to the Australian list, as well as another to the many links in the chain that connects the Australian with the Malayan fauna.

Theryaxia, nov. gen. Anthaxites. (Fam. Buprestidae).

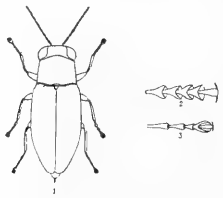
Head wider than the pronotum in front, forehead lightly convex and covered with well-marked reticulation; epistoma truncate, labrum bilobed, antennary cavities terminal, small, round, nearer the epistoma than the margin of the eye; mentum subtrapezoidal; maxillae angulately projecting at the base, antennae slender, toothed from the third onwards, the fourth and following furnished with terminal pores, at least on the apical segments. *Pronotum* wider than long, reticulated like the head, margined at sides, surface uniform. *Scutellum* of moderate size. *Elytra*: Surface uniform, without striae, its sculpture microscopic and silky; the posterior margins finely denticulate. *Prosternum* truncate anteriorly, finely margined, its process trifid. *Mesosternum* entirely divided, the lateral branches rather long and straight; posterior coxae straight on the anterior margin, dilated behind internally; the suture of the first two abdominal segments

clearly visible, the first suture not parallel to the following; the apex of the last segment rounded; the whole underside more or less reticulate; the lateral prolongation of the abdomen entirely concealing the metathoracic epimera.

Legs slender, femora furrowed along their lower margin, tibiae subcylindric, tarsi elongate, their first segment as long as the succeeding two combined, the fifth very short, not extending beyond the fourth.

THERYAXIA SUTTONI, n. sp.

Rather elongate, convex, its greatest width at the posterior fourth of its total length. Head and pronotum coppery, the latter turning to green at the lateral margins; elytra green bordered with red, except for a narrow green margin; underside coppery; antennae black, except the last two segments.



1.—*Theryaxia suttoni*, n. sp. 2.—Tarsus of *Melobasis*. 3.—Tarsus of *Theryaxia suttoni*. (Drawn by C. Deane.)

Head very wide, eyes large, very prominent and regularly continuous with the frontal outline, their anterior margin nearly straight; antennae extending to the front coxae, the first segment clearly longer than the two following combined, the second much longer than wide, a little shorter than the third, the rest subequal and furnished with stiff hairs. *Pronotum* strongly projecting in a rounded lobe at anterior margin, sides straight, feebly converging towards the apex, base widely bisinuate, the medial lobe widely rounded, sides margined by a very fine carina not extending to the front margin. *Scutellum* subtriangular, very finely sculptured. *Elytra* little prominent at shoulder, widening in a straight line towards the posterior third, thence rounded and narrowed to the apex, there separately rounded and very finely denticulate; margins, also suture nearly to the scutellum finely bordered; disc extremely finely sculptured, nearly smooth at the middle, without distinct punctures; prosternal process terminated by three points, the middle one not extending to the base of the sternal cavity; anterior margin of the metasternum rounded, the meso-metasternal suture very distinct; the last abdominal sternite more strongly reticulate than the others; posterior tibiae lightly enlarged at apex; tarsi about three-fourths the length of tibiae, narrow and enlarging only from the third segment onward.

This genus belongs to a small group of the Anthaxites having the head and pronotum distinctly reticulate, a group that includes *Xenorhipis*, *Tetragonoschema*, *Anilara*, *Anthaxia* and *Agrilaxia*, from all of which it is separated by the head being much wider than the apex of pronotum and the short fifth tarsal segment.

Dim.—4·75 × 1·75 mm.

Hab.—Queensland: Stanthorpe (Mr. E. Sutton).

I am indebted to Mr. Sutton for examples of this interesting Buprestid, one of the many discoveries of this keen entomologist in an interesting district; and also to Mr. C. Deane for his drawing.

NOTES ON *CORYSANTHES* AND SOME SPECIES OF *PTEROSTYLIS* AND *CALADENIA*.

By the Rev. H. M. R. Rupp, B.A.

(Four Text-figures.)

[Read 31st October, 1928.]

Corysanthes.

In "A Review of the Australian Species of *Corysanthes*" (Rupp and Nicholls, 1928) Robert Brown's name for this genus was retained by the authors in preference to Salisbury's, reference being made to Mr. E. E. Pescott's treatment of this point in the *Victorian Naturalist* for May, 1926. It has been suggested that, inasmuch as strict conformity to the international rules of the Vienna Conference requires that *Corybas* Salisb. shall have preference over *Corysanthes* R. Br., we ought not only to have given our reasons for transgressing those rules, but also to have recognized their authority, at least to the extent of including the revised nomenclature in our review. In deference to the second of these suggestions, we give below the names of the seven Australian species for which recognition is sought, as they should appear if Salisbury's nomenclature is to prevail:—

Corysanthes fimbriata R.Br. .. .. .. becomes *Corybas fimbriatus.*
Corysanthes diemenica Lindl. .. .. becomes *Corybas diemenicus.*
Corysanthes pruinosa Cunn. .. .. .. becomes *Corybas pruinosus.*
Corysanthes dilatata Rupp and Nicholls becomes *Corybas dilatatus.*
Corysanthes undulata Cunn. .. .. .. becomes *Corybas undulatus.*
Corysanthes bicalcarata R. Br. .. .. becomes *Corybas aconitiflorus* Salisb.
Corysanthes unguiculata R. Br. .. .. becomes *Corybas unguiculatus.*

With regard to our reasons for having retained the generic name *Corysanthes*, if we transgress the strict letter of the Vienna rules, we cannot feel that we transgress their spirit. The rule particularly concerned, it is true, aims at restoring order from the confusion created by the arbitrary exercise of private opinion; but in the fulfilment of this aim it surely ought not to ignore the principle of "honour to whom honour is due." Bentham (*Fl. Aust.*, Vol. vi, pp. 350, 351) long ago gave the soundest of reasons—which so far as we are aware have never been refuted—why Brown's *Corysanthes* should be preferred to Salisbury's *Corybas*. Australian and New Zealand botanists in general have accepted Bentham's standpoint, which we venture to hope may yet be adopted by international agreement.

The range of habitat of the species discussed in our review as *Corysanthes bicalcarata* R. Br. is wider than has been supposed. It occurs in New Zealand, where it has been known as *C. Cheesemannii* Hook. We have examined numerous specimens kindly sent by Mr. H. B. Matthews of Remuera, Auckland.

PTEROSTYLIS.

In earlier papers (These PROCEEDINGS, li, 1925, 299, and lii, 1926, 184) I endeavoured to supplement available information in regard to a number of Australian species of this genus, and to suggest cases where further investigation was desirable in order to check current determinations. Some of the questions then raised have since been satisfactorily settled, and further knowledge of Australian forms has been gained. Some additional notes may therefore be of interest to orchid students. A few points previously raised have been incidentally treated in an illustrated article, "Greenhood Orchids of the Paterson District" (*Australian Naturalist*, February, 1927), but the present notes will be found supplementary to this also.

P. ACUMINATA R. Br.—In September, 1926, Mrs. Edith Coleman sent me living specimens of the Victorian spring-flowering form of this species, which were unquestionably identical with our northern autumn flower. A year later the same collector sent, from Healesville, living specimens of the form associated with the name of Mr. A. J. Tadgell (Rupp, 1926). These "giants" were nearly twice as large as the type form in all their parts, but I found that otherwise there was no difference which could in any way justify separation from Brown's species, and I think that a varietal name must serve to distinguish them. The existence of such giant forms in several species of our orchids is exceedingly interesting, and merits further study. *Caladenia carnea* R. Br. var. *gigantea* Rogers may be cited as an analogous case, and similar instances may be found among two or three species of *Dendrobium*. I propose that the *Pterostylis* here referred to be recognized as *P. acuminata* R. Br. var. *ingens*, n. var.

P. FALCATA Rogers.—I have noted that the late Professor Launcelot Harrison accepted my determination of the large Greenhood found by him on Barrington Tops (Rupp, 1926, note on *P. Baptistii* Fitz.; also Rupp, 1928) as *P. falcata*. New locality for this fine species.

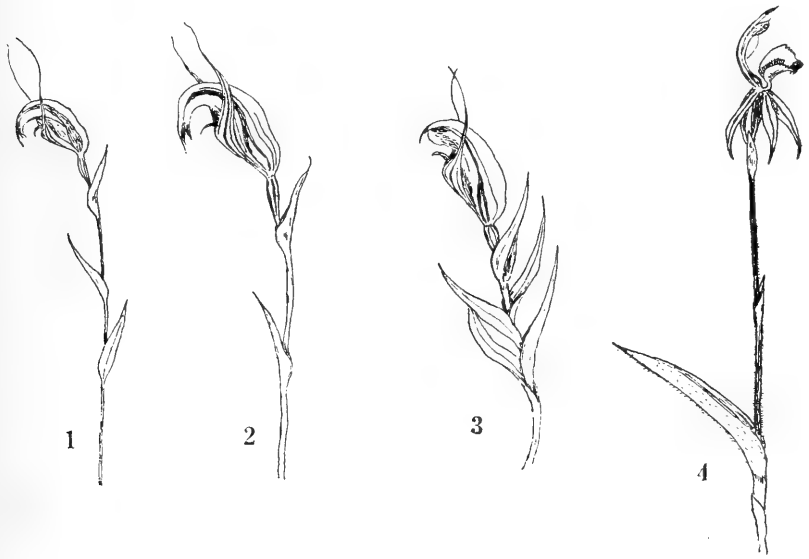
P. GRACILIS Nicholls (*Vict. Nat.*, March, 1927).—This is undoubtedly the plant previously discussed as of doubtful identity (Rupp, 1925, No. 8, and Text-figure 3). Mr. Nicholls concurs in this opinion after inspecting my specimens.

P. NUTANS R. Br.—Mr. H. B. Matthews, of Remuera, New Zealand, recently sent me herbarium material, in admirable condition, of a large number of New Zealand orchids. Some of these are conspecific with Australian forms, though in several instances known in New Zealand under different names. *P. nutans* is a case in point. The New Zealand plant named by the late T. F. Cheeseman *P. Matthewsii* is undoubtedly identical with R. Brown's species.

P. NANA R. Br. and P. PYRAMIDALIS Lindl.—No distinction can be detected between the former of these two species and the New Zealand *P. puberula* Hook., and they should be regarded as conspecific. The distinction between *P. nana* and *P. pyramidalis* (the latter being endemic in Western Australia) in the typical forms appears to be quite sufficient to endorse specific separation; but Lieut.-Col. B. T. Goadby has prepared a series of dissections of Western Australian forms which present some difficulties in determination. The type form of *P. nana* has an extensive range through all the southern States of Australia (including Tasmania), and is found in New Zealand. Except in Western Australia it displays little variation, except in size, and is readily determined. In the west, however, it would appear to be sometimes difficult to determine in regard to some forms whether they should be included under *P. nana* or the endemic *P. pyramidalis*, and it will probably be found that the two species, which are

closely allied, hybridize freely in Western Australia. The same remarks will apply, in my opinion, to *P. barbata* Lindl. and *P. turfosa* Lindl. The range of the former is practically identical with that of *P. nana*, except that it comes further north in eastern Australia. *P. turfosa* is a closely-allied Western Australian endemic. In Western Australia—and there only—forms occur which might be included under either species, and are probably the result of hybridization.

P. ALATA Reichb. f., P. REFLEXA R. Br., P. REVOLUTA R. Br., and P. ROBUSTA Rogers (Text-figs. 1-3).—If the notes numbered 19 (Rupp, 1925 and 1926) be read in conjunction with No. 8 (Rupp, 1927), it will be seen that there has been considerable confusion between forms included under one or other of these species. The recognition of Dr. Rogers's new species *P. robusta* (*Trans. Roy. Soc. S. Aust.*, li, 1927) should clear this away. *P. robusta* was formerly known in the southern States and Western Australia as *P. reflexa*, but it is very distinct from Brown's species. It is nearer to *P. alata*, and was included in this by Ewart and Sharman as var. *robusta*, but Dr. Rogers gives good reasons for separating it. The Western



Text-figs. 1-4.
1. *Pterostylis reflexa*. 2. *P. revoluta*. 3. *P. robusta*.
4. *Caladenia dilatata*, var. *concinna*, n. var.

Australian form has a narrower flower and a deeper colour than the type. It seems desirable to maintain Brown's separation of *P. reflexa* and *P. revoluta*, at all events until their relations have been more thoroughly investigated. The range of the latter is far more extensive than that of the former, and the differences, though slight, appear to be constant.

P. TRUNCATA Fitzg.—Since the publication of the earlier papers (Rupp, 1925, 1926) I have found quantities of this interesting species near Martin's Creek in the Paterson Valley, and Mr. W. H. Nicholls has recorded it on the Keilor Plains to the north of Melbourne.

P. CYCNOCEPHALA Fitzg.—It would be interesting to know whether this and the very closely-allied *P. mutica* R. Br. ever occur together. *P. cycnocephala* is

very abundant on the Barrington Tops, at 5,000 ft., but I could find no trace of *P. mutica*. Some 40 miles lower down, between Paterson and Maitland, the case is reversed: *P. mutica* is in great profusion but *P. cycnocephala* is absent.

P. TOVEYANA Ewart (See final note in Rupp, 1926).—The specific rank of this plant seems now well established. I have specimens from Frankston, Victoria (Mrs. Coleman). The same collector has sent some beautiful photographs of this orchid and its supposed "parents", *P. alata* and *P. concinna*; while I am indebted to Mr. T. Green, of Melbourne, for admirable stereoscopic studies of all three.

In the *Victorian Naturalist* for July and August, 1926, will be found two illustrated articles on "The Greenhood Orchids of Victoria", by W. H. Nicholls, which will be very helpful to all students of these interesting plants.

CALADENIA.

C. DILATATA R. Br.—Mr. G. V. Scammell forwarded living specimens in the spring of 1927 from Griffith, N.S.W., which show a marked divergence from the type-form of this species, perhaps meriting varietal distinction. The plants are consistently short-stemmed, the leaf being large in proportion. The paired sepals are not prolonged into filaments, and are equal in length to the petals, all being short. The dorsal sepal is slightly longer. These five segments are all acuminate, without any clubbed points. The point of the labellum is very short, and the long marginal combings so characteristic of this segment in the type-form are reduced to minute teeth. The colour-scheme agrees precisely with the type-form. The absence of combs to the labellum and of long points to the sepals gives this flower so neat and compact an appearance that I venture to propose its recognition as a new variety under the name *C. dilatata* R. Br. var. *concinna* (Text-fig. 4).

C. CARNEA R. Br.—Inconstant variations of this species are very common, but Dr. R. S. Rogers has described two consistent variants under the names var. *gigantea* and var. *pygmaea*. I wish to call attention to a third, which I have now had under observation for several years, and which appears to me to have originated by hybridization between the typical *C. carnea* and *C. caerulea* R. Br. The colour and markings are unquestionably those of the former, but in almost all other respects the plant closely resembles *C. caerulea*. It is extremely slender and rarely 6 inches high, and of many hundreds seen during three seasons I have failed to find one with more than a single flower. The leaf is broader than that of the typical *C. carnea*, and is very often flat on the ground, as in *C. caerulea*. As in the latter also, each petal is divided from the lower sepal by a fairly wide sinus. A faint bluish tinge is sometimes perceptible at the tip of the segments. This little plant occurs in great profusion in tea-tree scrubs of the Paterson Valley, where both the supposed parents are abundant. It is contemporary with *C. caerulea*, and precedes the typical *C. carnea* by a few weeks; but all three are found flowering together.

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NOTES ON SOME ADDITIONS TO THE *GLOSSOPTERIS* FLORA IN NEW SOUTH WALES.

By A. B. Walkom, D.Sc.

(Plate xxxvi, and thirteen Text-figures.)

[Read 28th November, 1928.]

This paper includes the results of the examination of portion of the collections studied at Cambridge during 1927 whilst holding an International Education Board Fellowship in Science. The descriptions included comprise those of (i) a collection of small *Glossopteris* leaves which belonged to the late John Mitchell, (ii) two terminal shoots (from the collection of the Geological Survey of New South Wales) which may possibly represent part of the plant which bore *Glossopteris* fronds, and (iii) a collection of seeds belonging to Mr. T. H. Pincombe.

The small *Glossopteris* leaves are of interest in that they show that the very small leaves are of the same form as the larger ones, which does not bear out Zeiller's suggestion that there is a gradual passage from the so-called "scale-leaves" to the normal leaves of *Glossopteris*. Some of the seeds in Mr. Pincombe's collection resemble very closely seeds described from Upper Carboniferous and Permian rocks in Europe and thus form a link between northern and southern floras of Upper Palaeozoic ages.

I take this opportunity of expressing my indebtedness to Mr. T. H. Pincombe and the late Mr. John Mitchell, both of whom collected extensively from the Newcastle Coal Measures, for their kindness in lending their collections for description.

(i). *Some small* Glossopteris *leaves from Belmont.*

Glossopteris Browniana Brongniart. (Text-fig. 1, 1*a*.)

(See Arber, 1905, p. 48.)

Three small leaves of the *G. linearis* type, with venation making a wide angle with the midrib, and with a fairly open, elongate, polygonal network are referred to *G. Browniana*. In such small fronds the venation must be regarded as the main feature for distinction since there is little, if any, difference in shape of the frond between those small leaves which have *G. Browniana* type of venation and those with *G. indica* type.

Localities.—Dirty Seam (Newcastle), and Belmont.

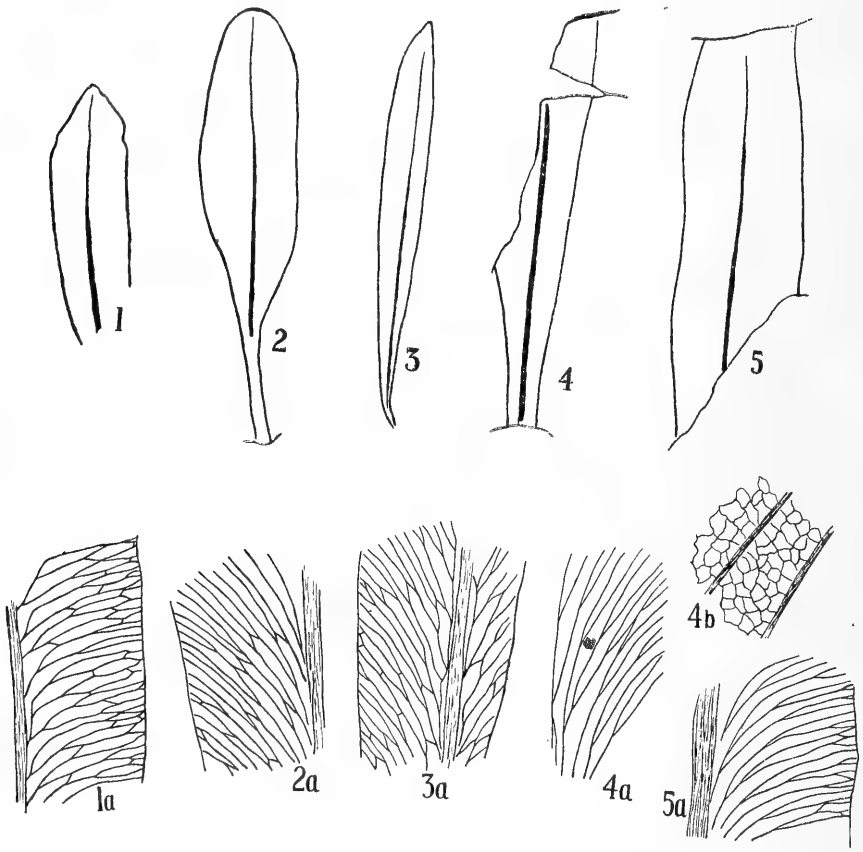
Glossopteris indica Schimper. (Text-fig. 2, 2*a*.)

(See Arber, 1905, p. 64.)

Three specimens from Belmont are referred with some hesitation to this common species. They differ somewhat from one another, but so long as the

venation forms the chief diagnostic feature of leaves of *Glossopteris*, as it does at present, there must be uncertainty in attaching definite specific names to many examples.

The specimen figured (Text-fig. 2) is one of the smaller leaves of *Glossopteris*, having a long petiole. In general appearance it might be compared with figures of *G. linearis*, more especially one figured by Feistmantel (1890, pl. xx, fig. 6), but the character of the venation, particularly the acute angles made by the short connecting veins, seems to me to justify comparison with *G. indica* rather than *G. Browniana*. The whole specimen is 5·9 cm. long, with greatest breadth 1·3 cm.; the apex is obtusely rounded and the leaf gradually narrows towards the base to a petiole which is about 1 cm. long. The midrib is prominent, 1·5 to 2 mm. wide



Text-figs. 1, 1*a*.—*Glossopteris Browniana* Brong. 1. Outline of leaf, natural size; 1*a*. Portion enlarged, showing venation (× 3).

Text-figs. 2, 2*a*.—*Glossopteris indica* Schimper. 2. Leaf, natural size; 2*a*. Portion enlarged, showing venation (× 3).

Text-figs. 3, 3*a*.—*Glossopteris angustifolia* Brong. 3. Leaf (× ¾); 3*a*. Portion enlarged, showing venation (× 3).

Text-figs. 4, 4*a*, 4*b*, 5, 5*a*.—*Glossopteris angustifolia* var. *taeniopteroides* Seward. 4, 5. Portions of leaf, natural size; 4*a*, 5*a*. Portions enlarged, showing venation (× 3); 4*b*. ? silicified cuticular cell structure (× 17).

at base of leaf, and becoming narrower towards apex; the secondary veins make an acute angle with midrib and curve gently outwards to margin.

Of the other examples one is a broad leaf, 3 cm. wide, and probably about 9 cm. long with venation more like that of typical *G. indica* than *G. Browniana*; the second is a narrower leaf, also perhaps comparable with some figures of *G. linearis*, but again the venation appears to place it closer to *G. indica* than any other species. It is probable that a re-examination of the whole of the *Glossopteris* species of New South Wales would solve some of the difficulties of determination, the bulk of the description being that in Feistmantel's work published in 1890.

Locality.—Belmont.

GLOSSOPTERIS ANGUSTIFOLIA Brongniart. (Text-fig. 3, 3*a*.)
(See Arber, 1905, p. 72.)

Two specimens from Belmont agree with Feistmantel's figure of an example from Blackman's Swamp, Newcastle, which he compared with *G. angustifolia* Brong. They are both abnormal, as was apparently Feistmantel's specimen, in having the lamina of different widths on the two sides of the midrib. The fronds are about 7·5 cm. long, the lamina being 4·5 mm. broad on one side and 2 mm. on the other. The lamina narrows very suddenly at about 1 cm. from base of petiole which itself is about 6·7 mm. long. The secondary veins make an acute angle with the midrib and form an elongate, narrow, polygonal mesh.

The Belmont examples compare very closely in size as well as in venation with Feistmantel's figures of young leaves of the species from the Raniganj Coalfield of India.

Locality.—Belmont.

GLOSSOPTERIS ANGUSTIFOLIA var. TAENIOPTEROIDES Seward. (Text-fig. 4, 4*a*, 4*b*, 5, 5*a*.)
(Seward, 1908, p. 113.)

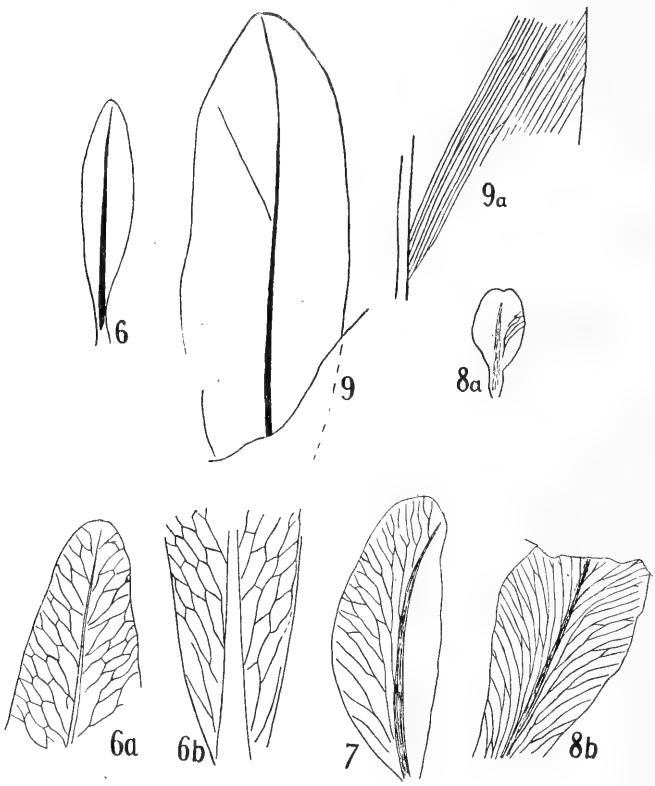
The leaves described under this varietal name from the Vereeniging Sandstone of Transvaal are characterized especially by the rarity of anastomoses of the secondary veins. In the shape of the leaf and the general appearance of the venation they correspond very closely with *G. angustifolia* Brongn., but differ from typical examples of this species in the almost complete absence of cross-veins connecting the secondary veins.

Two incomplete leaves are referred to this variety, one showing the basal portion of the leaf. As will be seen from the sketches of the venation (Text-figs. 4*a*, 5*a*) the veins frequently branch soon after leaving the midrib, but do not anastomose at all in the central portion of the lamina, and even near the outer margin cross connections are rather rare. There certainly appear to be more of such cross-veins than in the South African plants figured, but they are sufficiently rare in our leaves to justify some distinction from the typical *G. angustifolia*. It is possible that further discoveries may show that a complete series of intermediate forms exists, showing various stages between the species *angustifolia* and its variety *taeniopteroides*.

The Belmont specimens were probably considerably more than 6·5 cm. in length, and had a maximum breadth of about 1·5 cm.; the midrib is about 2 mm. wide at the base of the leaf, and gradually becomes narrower towards the apex; whether it persists to the apex or dies out before reaching it is not shown in these specimens. The midrib shows a number of vertical striations, apparently repre-

senting the downward continuation of the secondary veins. The secondary veins leave the midrib at an acute angle and curve outwards to the margin of the leaf; in the marginal region there are approximately 12 veins per 5 mm. of length of leaf. In portion of one specimen some of the cuticular cell structure appears to have been silicified and preserved. This shows a series of more or less regular polygonal cells, without trace of stomata, apparently representing the upper surface of the leaf. The sketch (Text-fig. 4*b*) represents a small portion of this structure highly magnified.

Locality.—Belmont.



Text-figs. 6, 6*a*, 6*b*, 7.—*Glossopteris conspicua* Fmtl. 6. Leaf, natural size; 6*a*, 6*b*. Portions enlarged, showing venation (× 3); 7. Small leaf (× 3).
Text-figs. 8*a*, 8*b*.—*Glossopteris spathulato-cordata* Fmtl. 8*a*. Small leaf (× ½); 8*b*. Leaf showing venation, natural size.
Text-figs. 9, 9*a*.—*Glossopteris Mitchelli*, n. sp. 9. Leaf (× ½); 9*a*. Portion of venation (× ¾).

GLOSSOPTERIS CONSPICUA Feistmantel. (Text-fig. 6, 6*a*, 6*b*, 7.)
(See Arber, 1905, p. 86.)

Arber's description is "Frond fairly large, spathulate, or oval-lanceolate. Midrib distinct. Secondary nerves forming very large, open, elongate meshes of approximately the same size throughout the lamina. Meshes oblong-polygonal, transversely elongate, much longer than broad."

Several specimens from Belmont belong to this species. The venation is characteristic, very closely resembling that of Feistmantel's figured examples, and differs from that of any other species of the genus. The size of the Belmont specimens (3·4 cm. long and about 8 mm. wide) is much less than that of those described from India. It may be pointed out that Arber's remark (1905, p. 87) on this species that the meshes are probably ". . . more open (i.e. broader in comparison with their length) than in any other known representative of this genus" is obviously incorrect and at variance with his remarks in the previous paragraph on the same page.

Locality.—Belmont.

GLOSSOPTERIS SPATHULATO-CORDATA Feistmantel. (Text-fig. 8*a*, 8*b*.)
(See Feistmantel, 1890, p. 128.)

Specimens were figured by Feistmantel under this name, but he did not give a diagnosis of the species. He considered that they may have represented a developmental state of a species of *Glossopteris* and simply gave them a distinguishing name, pointing out that they occurred in Tasmania as well as New South Wales.

Arber later (1905, p. 93) suggested the possibility that the specimens figured by Feistmantel might belong to the species *G. orbicularis* described by the same author from the Raniganj group of the Damuda division of India. There appears, however, to be considerable difference between the figures of the two species, not only in shape of leaf, but also in venation.

Two specimens in the present collection show close similarity with Feistmantel's figures of *G. spathulato-cordata*, more particularly his figures 7 and 8 (1890).

Leaf broadly oval, petiolate, apex widely emarginate; midrib very prominent, becoming narrower towards apex where it is not conspicuous; secondary veins at an acute angle to midrib, curving outward slightly, and forming very elongate mesh.

The larger of the two leaves does not show base or apex; it is 1·9 cm. wide at widest part and would probably have been approximately 5 cm. in length; at the margin there are about 5 veins per cm. The smaller leaf does not show the venation so clearly as the larger, but it is complete, having a total length of 2·9 cm. and greatest width of 1·4 cm. The lamina is broadly oval and the wide petiolar portion is about 7 mm. long.

The species is certainly distinct from any other Australian species of *Glossopteris*, and also appears to me to be distinct from the Indian *G. orbicularis* to which Arber suggested its possible reference.

It is perhaps interesting to note that the larger of the two specimens here described is a good example showing the continuation of the secondary veins as striae for a considerable distance along the midrib region.

Locality.—Belmont.

GLOSSOPTERIS (?) MITCHELLI, n. sp. (Text-figs. 9, 9*a*.)

One specimen shows a single frond, almost complete, elongate oval in shape, with a length of approximately 13-15 cm., and breadth of 3·8 cm. Apex obtusely pointed; midrib distinct, about 1·5 mm. wide near base and becoming very fine towards apex but persisting. Secondary veins make an acute angle (25°-30°) with midrib, pursuing almost a straight course to margin and anastomosing very occasionally.

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It is perhaps doubtful whether this specimen is rightly placed in *Glossopteris*. The differences between it and *Palaeovittaria* lie in (1) the midrib persisting to the apex whereas in *P. Kurzi* it is "scarcely visible, except in the basal portion of the frond, but indicated by a median fold." (Arber, 1905, p. 130), and (2) the presence of occasional anastomoses.

P. Kurzi, the only species of *Palaeovittaria* recorded, has been found in the Raniganj Coal Measures of India and in the Triassic Rocks of Tonkin (Zeiller, 1903, p. 81, Pl. xvi, fig. 1).

In specimens such as the one described here, it is difficult to know where to draw the line between *Glossopteris* and other genera. *G. Mitchelli* seems very close to *Palaeovittaria Kurzi* and it may be that the two are representatives of a single genus.

Locality.—Belmont.

(ii). *Terminal portions of shoots, possibly belonging to* Glossopteris.

Two specimens (Plate xxxvi, figs. 1, 2) from Gloucester, N.S.W., where they occur in rocks of the Upper Coal Measures (Permian), are the remains of the terminal portion of shoots in which the axis bore small pointed leaves arranged in a spiral manner. The larger specimen is about 6 cm. long and 1·6 cm. wide at lowest part, tapering to an acute apex; the smaller is 4·5 cm. long and 2·5 cm. wide, thus being comparatively much broader than the larger specimen. The small leaves vary somewhat in size, some being about 1·5 cm. long by 1 cm. wide, others more rectangular, 1·5 cm. long by 1·5-2 cm. wide; those nearer the tip of the shoot are longer and more slender than those below. They are traversed by a number of slightly divergent, dichotomously branching veins—about 2 veins per mm. of width—which, so far as can be observed, do not anastomose. In the larger of the two specimens the portions of some 14 or 15 leaves can be seen, and in the smaller about 10 leaves are visible. These specimens are quite unlike any that have come under notice by the author and it is hoped that the publication of a description and figure may lead to the discovery of additional specimens and a more complete knowledge of their nature.

The only published figure, observed by the author, closely resembling the two specimens here described is that of a specimen from the Permo-Carboniferous rocks of Kashmir (Seward, 1905, Pl. ix, fig. 2). This occurs in association with *Gangamopteris kashmirensis* and it was suggested by Seward (*l.c.*, p. 5) that possibly the specimen represented an imperfectly preserved piece of a stem with leaf bases. The arrangement of the supposed leaf bases appeared to be spiral and the distal margins were vaguely outlined and irregular. The general appearance of the specimen is very like our specimens and it seems probable that it is of similar nature. These specimens seem to be shoots showing the mode of occurrence of the so-called scale leaves of *Glossopteris*, of which isolated individuals have been recorded and figured from India (Zeiller, 1902) and Australia (Arber, 1905; Walkom, 1921, 1922), and as such they are of considerable interest in view of their possible relation to *Glossopteris* and *Gangamopteris*.

In the scattered examples of single leaves described as scale leaves of *Glossopteris*, no definite connection with *Glossopteris* has been proved, though there is a constant association with the *Glossopteris* flora. Figured examples show considerable variation in shape, but no more perhaps than can be observed in those of our specimens. Frequently also it has not been quite certain whether the veins of some of these scattered leaves anastomosed, so that the apparent

absence of anastomosis in our specimens is consistent with previously described examples. An example of one of these single scale leaves is figured for comparison (Plate xxxvi, fig. 3), and others can be seen on Plate xxxvi, fig. 4.

Whilst there is a strong possibility that these so-called scale leaves may represent portions of shoots borne by the same plant which bore *Glossopteris* fronds, it must not be forgotten that some small leaves which bear a rather close resemblance to them have been described as species of *Cordaites* (*sec* Seward, 1917, p. 237, fig. 468 C) and that the general form of the specimens described above is not unlike the inflorescence of *Cordaites* as restored by Grand-Eury (*see* Scott, 1923, fig. 99, p. 269; also Grand-Eury, 1877).

Zeiller, in his account of some of the scale leaves from India, suggests (1902, p. 13) the existence of series of leaves making a gradual passage between the scale leaves and the normal leaves of *Glossopteris*, but this does not appear to be the case in Australia, since very small leaves of *Glossopteris* do not differ in shape from the larger ones. Some of the small normal leaves are described and figured above (pp. 555-9).

If then, these "scale" leaves belong to the plant which bore *Glossopteris* leaves they might be either scale leaves, as suggested by Zeiller, comparable with the scale leaves of *Struthiopteris* (= *Onoclea*) or the leaves borne on special modified fertile shoots.

A feature worthy of consideration, not only in our specimens, but in other known examples, of the single isolated "scale-leaves" is the marked convexity of the leaf. This convexity suggests the possibility that the leaf perhaps covered a seed which may have been attached to the inner surface of the leaf since, in many cases, the leaf, though detached from the axis of the shoot, has been preserved with its markedly convex form, as though the seed might be still attached. It may be then that these were shoots which were reproductive in character, seeds being borne on the inner surface of small leaves in somewhat the same way as they are borne in the cones of many conifers. Whether they belonged to *Glossopteris* or *Gangamopteris* or to a member of the Cordaitales is uncertain.

I have before me also some very convex examples of the "scale-leaves" from the Upper Coal Measures, on the horizon of the Dirty Seam at Dudley in the Newcastle District, N.S.W., with which are associated groups of the small bodies which Arber (1905) described as the probable microsporangia of *Glossopteris*. These groups are about 1 cm. in diameter and contain numbers of the "microsporangia", as many as thirty being visible in a single group on the weathered surface of the specimen (Plate xxxvi, fig. 4). Whether they are actually microsporangia is uncertain, for one of them has been treated with hydrofluoric acid and then macerated with Schulze's solution, but no spores were detected. Further experiment is necessary in this direction.

Some similar bodies from the *Glossopteris*-bearing beds of South Africa have been examined in the same way by Mrs. Thomas at the Botany School, Cambridge, and she also has been unable to find any spores actually in the "microsporangia", though spores were obtained from the shale in which the fossils occurred.

Associated with the single scale leaves and groups of "microsporangia" from Dudley, there are also examples of the large winged seed described below (which seems too large to have been covered by the scale leaves in the manner suggested above) and also irregular masses of thin linear structures which may be the remains of masses of rootlets or may be of inorganic origin. It is perhaps more

probable that they are rootlets since they seem to show remains of a central vascular strand; it is impossible to say to what plant they may have belonged.

Glossopteris is abundant on the reverse side of the specimen, which is less than 1 cm. thick, and there are also a few fragments of *Glossopteris* leaves on the same surface as the scale leaves, "microsporangia", seeds, etc.

(iii). *Some seeds associated with the* Glossopteris *flora.*

In addition to the large seeds previously mentioned and described below as *Samaropsis Pincombei*, quite a number of small seeds have been collected by Mr. T. H. Pincombe at Belmont and Warner's Bay. They are all preserved as impressions and do not add much to our knowledge of the structure of the seeds, but they are of interest in that they have not previously been described from these localities, and they all represent types which are known from Upper Palaeozoic rocks of other parts of the world. The very close resemblance between some of these specimens and such types as *Samaropsis moravica* and *Carpolithes granulatus* is specially interesting as these types occur in Upper Carboniferous and Permian rocks in Europe associated with floras which have little, if anything, in common with the *Glossopteris* flora.

Samaropsis Pincombei, n. sp.

From two localities in the Upper Coal Measures of the Newcastle district specimens of a large winged seed have been obtained. The localities are (1) Bar Beach, Merewether, where the seeds are associated with *Phyllotheca*, *Glossopteris* and *Noeggerathiopsis*, at about the horizon of the Dirty Seam, and (2) Dudley, where they are associated with *Glossopteris*, scale-leaves (?) of *Glossopteris*, and clusters of the so-called microsporangia of the same genus, also on the horizon of the Dirty Seam.

An example of these is figured (Plate xxxvi, fig. 5). The spread of the wings is approximately 2·7 cm., and they are about 1 cm. in extent vertically. The seed itself is pear-shaped, about 8 mm. long, prolonged into a narrow spine-like apex about 1·5 mm. long. At its widest (near the apex) it is 5 mm. wide, narrowing to about 1·5 mm. near the base and then expanding at the place of attachment, where it is about 3 mm. wide. No detailed structure is shown beyond a number of vertical striations. The wings are attached to the main body of the seed as well as to the narrow apical projection, and are marked by numerous striations extending outwards from the edge of the seed in a gentle curve to the outer margin of the wing.

Reference may be made to a degree of similarity of the present species with *S. Zignoana* figured by Nathorst (1886, Pl. xxv), from the Rhaetic flora of Bjuf, Sweden.

Localities.—Bar Beach, Merewether and Dudley.

Samaropsis moravica (Helmhacher). (Text-fig. 10.)

One type of small seed is represented by specimens from Belmont in which the seed is about 4·0 mm. long and 1·5 mm. wide, each end being rather sharply pointed. There is a wing-like border which is incomplete but has a wide extent. The specimens (Text-fig. 10) resemble *S. moravica* (*cf.* Zeiller, 1892, Pl. xv, figs. 8-10) so closely that no good purpose would appear to be served in giving them a separate specific name. This type of seed has been recorded widely from Permian rocks in Europe, as well as from the Upper Carboniferous. Some specimens of

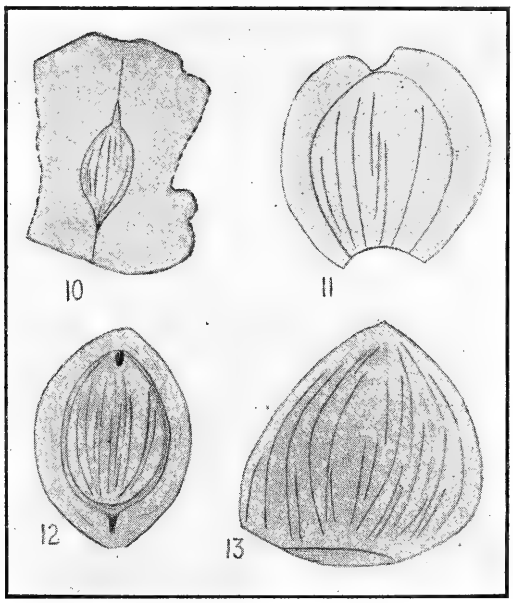
S. Seixasi, associated with *Gangamopteris* in the Santa Catharina beds of Brazil, and figured by D. White (1908) as *Cardiocarpon Seixasi* resemble *S. moravica* rather closely.

Locality.—Belmont.

CARPOLITHES BELMONTENSIS, n. sp. (Text-fig. 11.)

Small seeds, about 4 mm. by 3·5 mm., preserved as flattened impressions which show a central area bounded by a narrow flat region about 0·75 mm. wide. The central area has a few vertical ribs and the outer flat area is marked with fine striae parallel to the circumference; its continuity is interrupted by an apical depression, and at the base it ends against a concave lower surface of the seed.

This type of seed is the most abundant in the collection available.



Text-fig. 10.—*Samaropsis moravica* (Helmhacher).
Text-fig. 11.—*Carpolithes belmontensis*, n. sp.
Text-fig. 12.—*Carpolithes* sp.
Text-fig. 13.—*Cordaicarpus* sp. (narrow border not shown).
[Text-fig. 10, × 4; Text-figs. 11-13, × 8.]

The specimens exhibit a close resemblance to *Carpolithes granulatus*, originally described by Grand-Eury (1877), and figured under the name *Samaropsis granulata* by Zeiller (1892, p. 94) from the Basin de Terrasson in rocks belonging either to the top of the Upper Carboniferous or to the Lower Permian (Zeiller, 1892, p. 119). The Belmont specimens are not referred to the species *granulatus* in view of the suggestion that *C. granulatus* represented seeds of *Pecopteris* (Seward, 1917, p. 168).

Localities.—Belmont and Warner's Bay.

CARPOLITHES sp. (Text-fig. 12.)

Small oval seeds, one of which is figured in Text-fig. 12, probably belong to *Carpolithes*. They are about 3·5 mm. long by 2·5 mm. wide, and have a narrow flat outer area about 0·5 mm. wide, which is separated from the convex inner portion (nucellus) by a very narrow groove. Both the outer flat region of the impression and the nucellus bear fine vertical striations and the nucellus has a small vertical protuberance just below its apex.

Localities.—Belmont and Warner's Bay.

CORDAICARPUS sp. (Text-fig. 13.)

A small, roughly triangular, platyspermic seed about 4 mm. long and 4·5 mm. wide, with a broadly rounded base and a narrow border enclosing the nucellus.

This seed is referred to *Cordaicarpus* rather than *Samaropsis* on account of the narrow border, which is only about 0·5 mm. wide. In general appearance it is not unlike *C. Cordai* (*see* Seward, 1917, fig. 502C).

Locality.—Belmont.

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EXPLANATION OF PLATE XXXVI.

Figs. 1, 2.—Terminal shoots, possibly representing modified shoots of *Glossopteris* or of *Cordaites*. Gloucester, N.S.W. Nat. size.

Fig. 3.—"Scale leaf" of *Glossopteris*, for comparison with leaves of shoots shown in Figs. 1, 2. Nat. size.

Fig. 4.—*a*, "Scale-leaves" of *Glossopteris*; *b*, Groups of so-called "microsporangia" of *Glossopteris*; *c*, Rootlets (?); *d*, *Samaropsis Pincombei*, n. sp. Nat. size.

Fig. 5.—*Samaropsis Pincombei*, n. sp. (Drawing by Mr. T. A. Brock, of Cambridge). × 1·5.

THE CARBONIFEROUS ROCKS BETWEEN GLENNIES CREEK AND MUSCLE CREEK, HUNTER RIVER DISTRICT, NEW SOUTH WALES.

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(Plate xxxvii and seven Text-figures.)

[Read 28th November, 1928.]

Introduction.

The area described in this paper is part of the Carboniferous belt which runs along the northern and north-eastern margin of the Hunter Valley towards New England. In a former paper (Osborne, 1926) a detailed account was given of the structure and stratigraphy of that part of this belt which lies just to the north and north-east of Singleton, and the area about to be described extends directly from the western margin of the former district. The map (Plate xxxvii) embodies, on its eastern side, a little of the western portion of the map given in the paper cited above, in order to indicate quite clearly the relation between the two areas. Altogether about 140 square miles in the County of Durham have been mapped in detail, this area being bounded on the south and south-west by the great overthrust fault which is so important a feature in the geology of the Lower and Middle Hunter, and on the north by the line of ridges in which many of the southward-flowing streams, Goorangoola Creek, Bowman's Creek and others, have their rise. On the west the boundary is taken as Muscle Creek.

The field work was carried out in the course of two visits, and the successful completion of the work was made possible by the excellent hospitality and kindly interest shown to the writer by the local people. To Mr. H. M. Bailey and family of "Greylands", and Mr. J. Brosi and family of "Glen Alvon", Mr. and Mrs. Tom Glendinning of Muscle Creek and Mr. C. Ball and family of Bowman's Creek, and many others who have helped, the writer wishes to express his gratitude. Also he is indebted to Dr. W. R. Browne for helpful discussion of this paper during its preparation.

In the following pages the stratigraphy and structure will form the main topics of discussion, and a brief account of the outstanding features of the physiography will be given, but the petrography will not be treated at all.

Practically no geological work has been carried out in this area in the past, the only reference to it being in an Annual Report of the Mines Department of New South Wales. This deals with the occurrence of ironstone and limestone in the neighbourhood of Yellow Rock, Parish of Balmoral (David, 1886).

STRATIGRAPHY.

Preliminary.

The Carboniferous rocks are well developed in the area, representatives of the two series in New South Wales occurring, namely, the marine Burindi Series and

the terrestrial Kuttung Series. On account of the general belt-like arrangement of the Upper Palaeozoic terranes along the north-eastern side of the Hunter, and because the broad structure in these belts is a general dip towards the centre of the great geosyncline of Eastern New South Wales, the Burindi rocks outcrop to the north and north-east of the Kuttung rocks. But, as far as the limits of the present area are concerned, the Burindi rocks have in each case come into their present position against the Kuttung Series as a result of heavy normal faulting.

The Burindi Series.

The Burindi Series has not been studied in great detail, since the main problems of the area are associated with the Kuttung Series and its relation to the Permian System. Further, it is rather disappointing to try and unravel the detailed features of stratigraphy and structure in the Burindi areas, because of the nature of the beds and the absence of persistent horizons. Neither the base nor the top of the Series was observed and the greatest thickness of strata noted in the area was approximately 1800 feet.

These rocks are almost entirely sedimentary, one or two lavas being interbedded with the clastic rocks, and a few small felsite dykes occurring. The lavas are all sodic and felsitic and not unlike the general type met with in the Kuttung Series.

The sediments comprise agglomerates, tuffs, shales, limestones, some of which are oolitic and some very impure, and breccias. The limestones vary a good deal in texture and composition, and at times grade into calcareous tuffs. They carry a varied fauna, and the fossils collected appear to be the usual Burindi forms which have been listed and described in many papers upon the Carboniferous rocks of New South Wales. The tuffs are peculiar in appearance, being at times very finely textured, and at other times quite coarse and variable. Most of the rock fragments are acidic and the mineral chips comprise quartz, albite and orthoclase. The general matrix is also acidic, often containing a certain amount of biotite. The breccias are related to the tuffs, and are never very extensive, but point to the presence of volcanic foci where explosive eruptions occurred from time to time.

The conglomerates vary very much in texture and in general composition. In the majority of cases the constituent pebbles are up to a maximum of nine inches in diameter, with an average of about three and a half inches. The matrix is generally tuffaceous or arkosic, and amongst the pebbles there is a great variety of acidic igneous rocks, quartzites and cherts. But in some cases these conglomerates become very different in character from the dominant type. An example of this is to be seen in the left bank of Fishhole Creek near Portion 33, Parish of Herschell, where the pebbles in the conglomerate are no greater than three-fourths of an inch in diameter. In some of the shaly bands among the tuffs there are plant remains, chiefly indeterminate stems and macerated material, but occasionally some definite examples of *Lepidodendron Veltheimianum*, and other species are seen.

There is no distinctive order in the sequence, but, taking the rocks as a whole, there is a greater amount of limestone and tuff in the lower portion of the Series and a dominance of thinly bedded mudstone in the upper portion.

Distribution of the Burindi Series.

The Burindi rocks outcrop in the upper portions of the streams which flow southward to the Hunter River. Thus these rocks are seen near the heads of

Glennies Creek, Bowman's Creek (Foy Brook), Goorangoola Creek and at the locality known as Yellow Rock in the Parish of Balmoral. There are two main areas of Burindi rocks. The first stretches from the head of Lincoln's Creek past Yellow Rock towards Rouchel Brook. This area is the surface of a wedge of the marine rocks standing as a horst-like structure in the Kuttung Series, which is faulted down on either side. The second area is at the head of Campbell's Creek and to the eastward (see map), and is bounded on the south by a strong fault. The rocks are mostly olive-green mudstones and impure limestones in this province, but occasionally there is some very richly fossiliferous limestone with masses of crinoid stems. The northern part of the Razorback Ridge is formed of Burindi rocks and from here they pass over to the east, outcropping eventually in Carrow Brook and on the Paterson River.

The Kuttung Series.

General.

The Kuttung Series outcrops in a belt eight miles wide which is continuous with the belt near Bridgeman. This was described in the earlier paper (Osborne, 1926) and it was pointed out that the Kuttung rocks showed a division into two volcanic series with associated sediments and a further distinctive series of sediments called the Main Clastic Zone. The rocks associated with the younger of the two volcanic series include glacial beds. In the paper referred to, very little was said regarding correlation with the type area of the Paterson-Clarencetown district. In the area now under discussion there are rocks corresponding to all groups represented in the Glendonbrook district, but the equivalents of the Main Clastic Zone occupy only a small portion of the area. The remainder of the rocks comprise two groups which are the equivalents (respectively) of the Volcanic Stage and Glacial Stage of the Paterson region.

It is not possible to say very much of the petrographical details of the lavas and tuffs without some chemical analyses, as the microscopical examination is often not conclusive, and only permits of a general classification. In view of this it has been decided to adopt the policy used in describing the Glendonbrook area, by referring to the many fine-grained lavas as felsites, distinguishing the more important flows by giving locality names.

The belt of lavas and tuffs near Bridgeman, which was described in this way, can be traced with ease in the field to the neighbourhood of Coalhole Creek, and it has been possible to retain some of the distinguishing names used for those felsites. Beyond Coalhole Creek, however, on the western side, there is a complicated faulted area where the glacial beds and the volcanic series are mixed up, and beyond this again is the Muscle Creek district where the Volcanic Stage is well developed. Here there is an apparent difference in the general facies of the volcanic succession, some types quite different from those at Bridgeman having come into the sequence. It is necessary, therefore, to discuss the Muscle Creek district separately, and to deal with the rocks from Bridgeman to Antiene in the manner adopted for the Mirannie area.

Owing to a normal fault, described below as the Brushy Hill fault, there is a duplication of the Volcanic Stage between Glennies Creek and the head of Muscle Creek and one has not been able to correlate with certainty the lavas in the northern belt with those in the southern or down-thrown portion which, as explained above, is the continuation of the Bridgeman belt. For that reason locality names have been given to the more important units in the north.

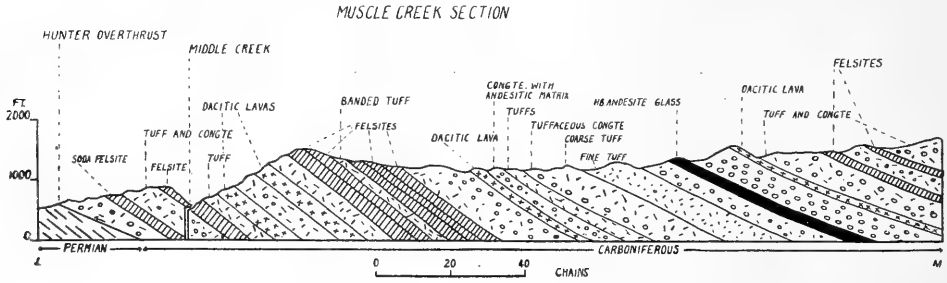
Finally, it should be stated that in the Volcanic Stage there are two different horizons of sediment, which resemble varve-rocks, but there is no definite evidence to prove whether these rocks are of glacial origin or not.

THE VOLCANIC STAGE.

This Stage is in contact with the Permian System right along the faulted junction from Glennies Creek to Antiene, a distance of twelve miles. Nowhere has the base of the Stage been seen, but the top may be studied at Dawson's Hill and near Owens Mount. A number of sections have been measured and these may now be considered, starting at the north-west end of the area.

Muscle Creek Section (Line LM on map; Text-fig. 1).

This section begins at a point a little to the east of the Muscle Creek Road in portion 18, Parish of Balmoral, on Permian rocks, and in a short distance crosses the Hunter Overthrust (described below), and passes on to Kuttung conglomerate and tuff. Then follows a thick series of lavas, tuffs and conglomerates. The first lava is a soda felsite, pink in colour, with biotite and felspar phenocrysts. It is overlain by tuffaceous conglomerate and a decomposed lava. This is succeeded by tuff, almost free from pebbles and then some felsite lavas of a general light colour, which under the microscope appear to be dacitic pitchstones that have been devitrified. These rocks are followed by tuffaceous conglomerate, the pebbles of



Text-fig. 1.—Section LM on Map.

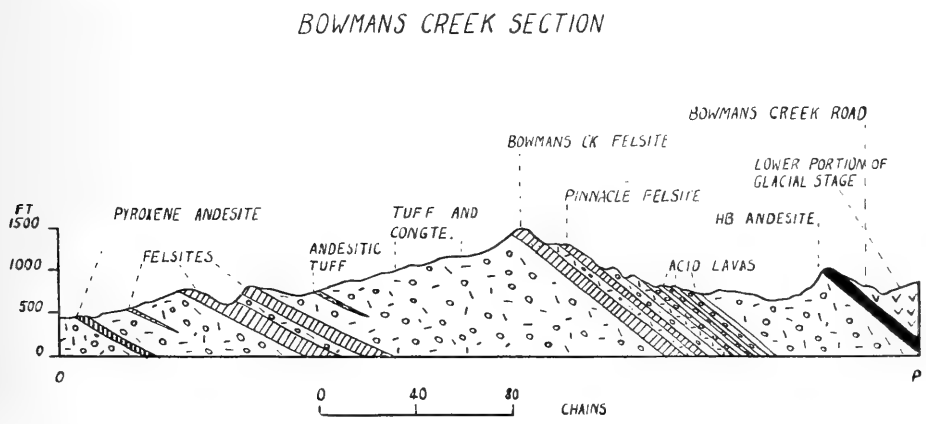
which reach a maximum diameter of six inches. The next unit is a brown lava with hackly fracture, and a general andesitic or dacitic character. It is succeeded by acid tuff and a series of flows with intercalated tuff. Most of the lavas in this group are also of dacitic nature, although their exact identity is difficult to determine. They contain a certain amount of glassy material in the groundmass and show the presence of albitized plagioclase. They are followed by a mass of tuff and conglomerate, and then there is another flow of soda-felsite, overlying which is a tuffaceous conglomerate, the matrix being distinctly andesitic. A variety of tuffs and tuffaceous conglomerate now continues and then a flow of andesitic pitchstone allied to the Martin's Creek type. This is free from devitrified phases. It is succeeded by conglomerates, the constituent pebbles including many representatives of pink aplite. Three more lavas interspersed among these conglomerates are light-coloured and of a general felsitic and sub-acid character. The top of the Volcanic Stage is not reached here, as the Brushy Hill Fault cuts the series short. This section, however, is the most complete that is available throughout the area.

A summary of the section, descending stratigraphically, is as follows:—

	Feet.
Tuffaceous conglomerate	300
Felsite	80
Tuffaceous conglomerate	200
Dacite	100
Coarse tuffaceous conglomerate	400
Biotite-felsite	50
Coarse conglomerate	300
Andesitic pitchstone	80
Conglomerate and tuff	200
Fine tuff	300
Coarse tuff	100
Conglomerate	100
Acid tuff	170
Conglomerate with andesitic matrix	90
Soda-felsite	60
Conglomerate	200
Tuff	80
Dacites (devitrified)	245
Tuff	100
Felsites	220
Coarse tuff	200
Felsite	150
Tuff and conglomerate	200
Dacite	170
Tuff and conglomerate	95
Felsite	85
Tuff	200
Soda-felsite	90
Tuff and conglomerate	230
TOTAL	4,795

Bowman's Creek Section (Line OP on map; Text-fig. 2).

Just to the north of the Brushy Hill Fault on the left bank of Bowman's Creek (Foy Brook), one finds pyroxene-andesite which is partly lithoidal and partly glassy, and identical with the well-known pyroxene-andesites of the Lower Hunter Valley. It is overlain by tuffaceous conglomerate, in the lower part of which is a small intercalated mass of andesitic tuff possessing distinctive characters. Towards



Text-fig. 2.—Line OP on Map.

the top of the conglomerate there are many bands of tuff, some of which contain remains of *Rhacopteris*. This plant-bearing tuff makes a bluff-like feature extending for at least a mile to the east of the line of the section. The conglomerate is capped by the Bowman's Creek felsite which is a light coloured rock with many phenocrysts of felspar and biotite. This rock is followed by more conglomerate and then the Pinnacle felsite, so-called because of its strong development on the summit and flanks of a hill in Portion 311, Parish of Foy, which is known locally as the "Pinnacle". This felsite is somewhat similar in appearance to the Bowman's Creek rock, but is subject to greater variation in texture.

After some fine tuff, there follows a series of acidic lavas and intercalated conglomerates. The lavas all possess a general pink or buff colour, except where they have been devitrified and impregnated with haematite. They vary a good deal from place to place, but are probably dacitic in composition. In the conglomerates associated with them there are some shaly partings containing *Cyclostigma* and *Lepidodendron*. On top of these interesting igneous rocks there is more conglomerate, in which the boulders reach a maximum diameter of 4 feet. These rocks pass under the hornblende-andesite (Martin's Creek type) which forms the capping to the ridge running along parallel to the Bowman's Creek road.

A summary of the above section is as follows:—

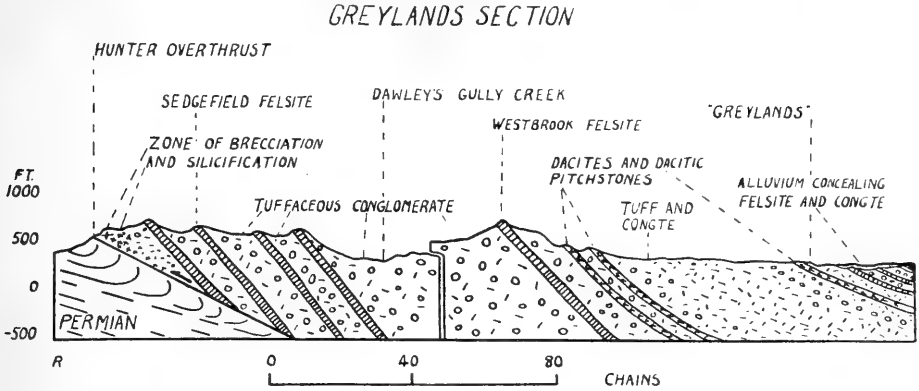
	Feet.
Hornblende-andesite	150
Conglomerate and tuff	200
Felsites with intercalated conglomerate—	
Lepidodendron	300
Tuffs	40
Conglomerate	25
Pinnacle felsite	70
Conglomerate and tuff	80
Bowman's Creek felsite	100
Conglomerate with tuff bands—*Rhacopteris*	800
Andesitic tuff	40
Conglomerate	150
Felsite	60
Conglomerate and fine tuff	50
Felsite	100
Conglomerate with thin band of soda felsite	500
Pyroxene-andesite	90
TOTAL	2,755

The Greylands Section (Line RT on map; Text-fig. 3).

The Greylands Section crosses the Volcanic Stage rocks which are directly continuous with the Bridgeman belt, but reveals many features which are not seen near Bridgeman.

Starting upon the Permian rocks in Portion 217, Parish of Goorangoola, and proceeding north-east, one finds the zone of the overthrust fault characterized by a very distinctive set of features. There are many types of brecciated and silicified rocks which have been fractured by the thrusting and subsequently altered by mineralization. In the breccias, some of the Permian rocks are intimately mixed up with the Carboniferous types, and much of the lowest felsite in the latter group has been intensely silicified. In this locality a considerable quantity of basalt (probably Tertiary in age) has come up along the fault zone. Beyond the brecciated zone comes conglomerate and tuff, and one bed of felsite-breccia with fragments up to an inch in diameter. Overlying this is the first unaltered felsite,

which contains many small red felspar phenocrysts. This is followed by a very coarse conglomerate, many of the pebbles being of finely banded rhyolite, and then the Sedgefield felsite, which in turn is succeeded by a series of acid lavas interbedded with coarse tuffaceous conglomerate, of the type characteristic of the Volcanic Stage. The conglomerate becomes quite thick in Dawley's Gully and is followed by the Westbrook Felsite, a light-coloured rock with a few phenocrysts of felspar. This is a very persistent horizon and makes characteristic ridges running from Westbrook to Bowman's Creek. It is overlain by some more conglomerate, with which are interbedded two or three flows of dacite, some being vitreous and some lithoidal. The sediment following the dacites is mostly tuffaceous, although there are two or three distinctive bands of conglomerate.



Text-fig. 3.—Line RT on Map.

This tuff is well developed in the depression to the west of "Greylands" homestead, and it maintains a fairly constant texture and composition, the latter being keratophyric. After the thick mass of tuff there is another devitrified dacite and then, showing through the alluvium of Goorangoola Creek, there are three acidic lavas, one of which is associated with some volcanic conglomerate.

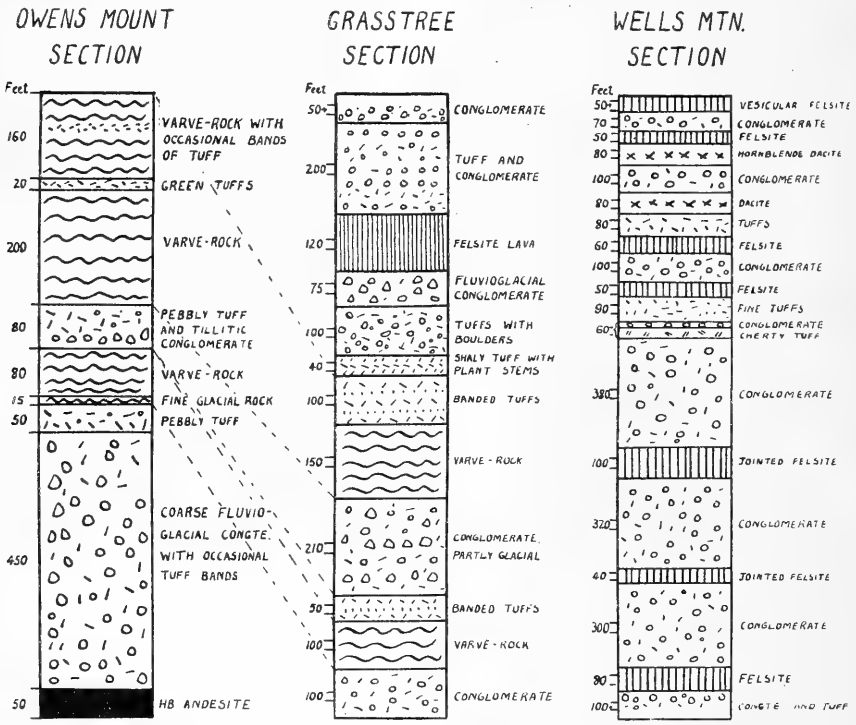
The thicknesses of the units described above are:—

	Feet.
Conglomerate	50
Dacite and volcanic conglomerate	40
Conglomerate	50
Felsite	30
Conglomerate	40
Dacitic lava	30
Tuff	50
Dacite	35
Tuffs with conglomerate bands	700
Dacite and pitchstone with interbedded conglomerate	300
Conglomerate	70
Westbrook felsite	700
Felsite and associated conglomerate	420
Sedgefield felsite	50
Conglomerate	100
Dacitic lava	60
Conglomerate	200
Zone of brecciation and silicification	120
TOTAL	3,045

The Wells Mountain Section (Text-fig. 4).

In the neighbourhood of Wells Mountain, a bald hill that stands up out of the country between Bowman's Creek and Cedar Creek, there are certain units in the Volcanic Stage, which are not developed elsewhere.

In the first place there are some peculiarly jointed felsites which outcrop in the gully of Sawyer's Creek, dispersed through about 1,000 feet of tuffaceous conglomerate. Then again, in a small creek running along the south-eastern



Text-fig. 4.

side of Wells Mountain there is a section through some of the beds which overlie the last-named conglomerate. This section embraces some interesting cherty tuffs carrying plant stems—no actual leaf remains being seen. Above the rocks exposed in the creek there is more conglomerate and altogether five lavas. These outcrop on the shoulder and summit of the mountain. The lowest flow is a pale-coloured aphanitic rock with inclusions. The next, which follows after the intervention of some tuff, is a dacitic type, which has originally been partly glassy. This, after some more conglomerate, is overlain by the third flow, which is a distinctive dacite, with much phenocrystic plagioclase and some hornblende and biotite. The fourth type is a felsite containing some red felspars, many of which are quite large. After some conglomerate a vesicular felsite makes the fifth unit. This vesicular rock is full of inclusions and forms the capping to the mount. The details of the thicknesses in this section are shown on Text-fig. 4, which is a generalized section.

Other Volcanic Stage Areas.

In addition to the sections considered above it is instructive to consider certain localities where other interesting Volcanic Stage rocks occur. On the western side of Grasstree Ridge there is an area occupied almost entirely by pyroxene-andesite. Here there appears to be a series of flows of both glassy and lithoidal andesite, which show the usual facies for this type of lava. In addition, however, there are some altered varieties which have probably suffered as a result of the operation of late-magmatic solutions. The lowest of the flows is intimately associated with a coarse conglomerate, pebbles of this being found in amongst the andesite.

Near Owens Mount the Martin's Creek type of andesite, the topmost lava in the Volcanic Stage, is developed in a trough-like structure. Associated with its glassy and lithoidal phases there is, especially at the north-eastern side of the basin, a group of peculiar andesites and dacites. These were probably originally very similar in character to the normal andesite, but magmatic waters have affected them and caused very marked changes. Some varieties are very much albitized and in some the groundmass has been chloritized to such an extent that the rock is now a tough greenish unit, quite dissimilar to any of the usual andesitic types.

In the area to the north of Bowman's Creek Village the Volcanic Stage comprises many varieties of tuff and conglomerate as well as felsitic and dacitic lavas. The tuffs can be seen on the bridle-track between Bowman's Creek and Muscle Creek, especially at Kelly's Gap. There is often a fine grained tuff rich in biotite, and at other times a coarse quartzose type with much ferruginous cement.

Then right on the western side of the area just considered, there is a group of lavas underlying the tuffs of Kelly's Gap. The most important of these is a blue andesite, which is probably related to the pyroxene-andesites of Grasstree, and an andesitic tuff which has some features in common with an andesitic tuff described from the lower part of the Bowman's Creek section.

On the eastern side of Bowman's Creek there is quite a variety of lavas which are not at all persistent. Most of these are aphanitic, some having a dacitic composition, and representing devitrified glasses. One of these dacitic rocks is of unique interest because it passes into a very fine volcanic conglomerate. This may be seen to advantage in the bed of Bowman's Creek in Portion 153, Parish of Foy. Here it is fairly clear that the lava has flowed over a mass of uncompacted gravel which has been incorporated into the lower portion of the flow. While the under surface zone is full of undigested sediment there is an absence of this in the upper portion, showing that the mass is not a sill.

Some tuffs in this area are very fine-grained and of a dark green colour, and in one or two instances altered contacts, caused by the metamorphic action of an overlying flow, have been seen. In these cases the greenish tuff has been converted into a rock very similar in colour and texture to ordinary basalt. One outcrop of fine sediment in the south-east corner of Portion 237, probably a tuff, has a distinct lamination and a variation in grainsize which give it much of the appearance of varve-rock, but the absence of other definitely glacial characteristics makes it very probable that the rocks were not connected with ice action. Some of the conglomerates become very coarse in this locality and show very imperfect sorting of the boulders, which at times are up to four feet in diameter.

Cross' Creek, a tributary of Campbell's Creek, drains an area of Volcanic Stage rocks immediately to the north of the Brushy Hill Fault. In this locality

there are some types which do not occur anywhere else in the area. They are all porphyritic with cryptocrystalline groundmass and of a greenish or pinkish colour. Two of seven types collected are spherulitic, and sometimes the spherulitic structure shows out remarkably well if the rock has weathered a little. One good example of such a lava is found capping a hill in Portion 108, Parish of Foy. In the bed of Cross' Creek also, there are some outcrops of jointed lavas, which have been altered by magmatic waters, and associated with these there are some extraordinarily coarse conglomerates, one or two boulders being more than eight feet in diameter.

BRIEF DISCUSSION OF THE STRATIGRAPHY OF THE VOLCANIC STAGE.

In no particular district has a complete section of the Stage been obtained. The lowest rocks stratigraphically are the pyroxene-andesites on the western side of the Grasstree Ridge and on the eastern bank of Bowman's Creek. The andesites near Grasstree are surrounded by faults and their relations to the adjacent rocks are doubtful, but on Bowman's Creek they are followed by higher members of the Volcanic Stage.

Taken as a whole, the rocks exhibit a number of distinctive features. The main group of units in the Volcanic Stage extending across from Glennies Creek to Wells Mountain shows an interesting sequence and it has its equivalent in the belt stretching from Dawson's Hill to Bowman's Creek. In the latter belt there are two outstanding felsites which have been termed the Bowman's Creek felsite and the Pinnacle felsite respectivly. From all the evidence available it is probable, though not proven, that these units are the equivalents respectively of the Sedgefield and Westbrook felsites in the southern belt. The highest unit in either belt is the hornblende-andesite and andesite glass.

Now in the Muscle Creek area there are many acid flows, but while some of these appear in certain ways to resemble some of the flows to the east, no definite correlation is possible, and, on the other hand, it is clear that a number of new types have come into the succession. In addition there is a flow of hornblende andesitic pitchstone, Martin's Creek type, which is not the stratigraphical equivalent of the andesites at the top of the Volcanic Stage elsewhere, but is a second unit of this well-known type.

The greatest thickness of the Stage occurs at Muscle Creek, namely 4,795 feet, and it is probable, from what has been seen in adjoining areas, that the faults, which occur at either end of the Muscle Creek section, have been responsible for cutting out about 2,000 feet of strata.

Although detailed petrographical work has not yet been done upon the lavas and tuffs, there are some general features regarding the broad succession that may be considered. In the two belts in the central and eastern portions of the areas, the sequence starts with pyroxene-andesites, which are succeeded by a great variety of dacites and felsites, many of the latter being sodic, and many of both sets being the devitrified equivalents of certain originally vitrophyric types. The last rocks to be poured out, namely, the hornblende-andesites, were of more basic composition than the bulk of the series.

In the Muscle Creek area the general sequence is somewhat different, as there are many andesitic and dacitic rocks near the base of the Stage, all of which are somewhat more acid than the pyroxene-andesite but distinctly less acid than the bulk of the felsites in the eastern portion. Of course, there are some of these more acidic types at Muscle Creek, but they are subordinate to the dacites and

andesitic tuffs. The occurrence of the hornblende-andesite amongst the dacites is a fact that increases the interest of the Volcanic Stage in this district.

Considering the whole of the area it is noticeable that the toscanites and dellenites, which are so prevalent in the Carboniferous areas between Gosforth and Clarencetown, are practically absent, unless some of the acid lavas are texturally different from, but chemically equivalent to these toscanitic types.

GLACIAL STAGE.

The rocks belonging to this Stage may be divided into two groups, the Lower Portion and the Main Glacial Beds. This subdivision is the same as that applied to the Kuttung Series over a region of 400 square miles between Mt. Tyraman and Limeburner's Creek, which includes the type-area.

In the account of the Mirannie-Dyrring area the beds corresponding to the Lower Portion of the Glacial Stage were referred to as the Main Clastic Zone, and succeeding these, in that area, there is a group of lavas and tuffs with subordinate glacial beds. Chief among the lavas are some toscanites, not unlike the Paterson type occurring to the east, and these underlie the small group of glacial beds.

In the present area the Lower Portion of the Stage is developed on the south-west side of the Razorback Ridge and at Owens Mount. In the former place there are some 1,600 feet of tuffaceous sandstones and occasional bands of fluvioglacial conglomerate. The facies of these rocks is almost identical with that of the rocks in the Mirannie area. Near the top of the series there are some shaly tuffs which contain indeterminate plant remains. The Lower Portion just briefly described is succeeded by a toscanitic lava, which caps the northern part of the Razorback range. This is overlain by some representatives of the Main Glacial Beds, but these have not been studied in this locality.

The Main Glacial Beds show a much better development at Owens Mount and near Grasstree, and two generalized sections for these localities are given in Text-figure 4.

The Owens Mount Section.

Following the hornblende-andesite at the top of the Volcanic Stage there is a very coarse conglomerate with a lithology somewhat different from that of the conglomerates of the underlying beds. The total thickness including a few bands of tuff is about 450 feet. The boulders in the deposit are very variable in size and reach a maximum of six feet in diameter. Many of the pebbles are sub-angular and some possess glacial striae. This basal conglomerate, in the opinion of the writer, was synchronous with the lowest of the clastic rocks occurring on the Razorback Ridge, from which, however, it differs strongly, lithologically. It would appear that while the Razorback area was receiving sediments from the north and north-west, the Owens Mount and Grasstree areas were the site of accumulation of bouldery deposits derived from the glaciated regions to the south-west. This basal conglomerate is the equivalent of a somewhat similar deposit recorded by the writer from the Paterson area (Osborne, 1922, p. 180), and of a mass of basal conglomerate described by Browne (1926, p. 226) for the Gosforth district. And further, the relationship, described above, between the lowest horizons in the Glacial Stage at Owens Mt. and Razorback Ridge is exactly analogous to the relationship discussed by the author for the basal beds of the Glacial Stage at Gosforth and Moonabung respectively (Osborne, 1927, p. 99).

There is no lava in this section equivalent to the toscanite on the Razorback Ridge and elsewhere, and a rather arbitrary line has to be drawn between the two divisions of the Glacial Stage. This is best placed at the top of the coarse basal conglomerate about 500 feet above the base of the Stage. The rocks following the conglomerate comprise varve-rocks, tillitic conglomerate and fine tuffs aggregating 600 feet. These are well exposed around the summit and shoulders of Owens Mount. The varve-rocks, of which there are two main horizons, are variously coloured, but some distinctive green and purplish varieties occur. Contemporaneous contortions and dropped pebbles are not uncommon features. Frequently bands of fine tuff are interbedded with the upper horizon of varve-rock.

Grasstree Section (Text-fig. 4).

The Grasstree glacial beds belong entirely to the Main Glacial Beds, and it is probable that the Lower Portion of the Stage is faulted out of sight. Beds which are stratigraphically higher than any occurring on Owens Mount are to be seen near Grasstree Trig. The most complete section to be obtained is on the northern side of this eminence. Here there are many varieties of tuff, tillitic conglomerate and some varve-rocks. The last-named form an important horizon 150 feet thick, but are also present in thin bands interbedded with the tuffs succeeding the main mass of varve-rock. By correlation with the glacial beds exposed in the gullies of Coalhole Creek, it is seen that another and lower horizon occurs in this area and the details available hereabouts are incorporated in the section. The lowest unit in this district is a bed of conglomerate 100 feet thick which is different lithologically from the thick basal conglomerate of the Owens Mount section.

Above the upper varve-rock there is a series of conglomerates, some bands of which contain scratched and faceted pebbles and occasionally large erratics. Interbedded with this coarse clastic sediment is a felsitic lava.

Regarding the correlation between the Owens Mount and Grasstree sections, only the two horizons of varve-rock and the tillitic conglomerate in between these can be matched in the two sections, and this has been indicated in Text-figure 4. But nothing more than this is possible. The writer does not think it advisable to try and correlate *over wide areas* the many varve-rock units (some of which are of very small thickness), which occur throughout the Carboniferous belt of the Hunter Valley, but in the present case the sections are taken from localities which are in fairly close proximity, and there is justification for assuming that the conditions of deposition and the general order of accumulation were much the same at the two localities.

STRUCTURE.

General.

Owens Mt. Basin.

The area shown upon the map has been folded along a north-west axis and subsequently cross-warped in an east-north-east and west-south-west direction. These two sets of folding were phases of the same diastrophic movement which occurred at the close of the Palaeozoic Era. The result of this cross warping has been the production of flat basin-like depressions and irregular dome-shaped structures complementary to the former.

In earlier papers the basin structures which occur in the country to the east of the present area were described, e.g. the Moonabung, Mirannie and Bridgeman Basins. The last of these is on the eastern margin of the area under present consideration, and it stands out well by reason of the outcrops of the andesite,

which have affected very materially the topography in the Mt. Pleasant and Mt. Olive districts.

To the west of the Bridgeman Basin the rocks are soon warped back into a simple dipping structure which continues to the southern part of the Greylands Station. Here, there is a very flat and irregular pitching anticline which joins the Bridgeman Basin with another to the west, which will be called the Owens Mt. Basin. The general dip referred to above, however, carries on in the northern section of the area.

Owens Mt. Basin is the central structural feature of the southern belt of the Kuttung rocks, and a glance at the map shows it to be clearly defined by the plan of the outcrops of hornblende-andesite. The general trend of the axis of this elongated basin or trough is E. 15° N. Within the limit of the elliptical outcrop of the andesite the length of the major axis is six miles and that of the minor axis, one mile. These figures give some idea of the shape of the trough. To the north-east the structure is sharply truncated by the Brushy Hill fault, while on the other side, also, faults are seen cutting off the lower units of the basin. The lowest beds in the structure can be seen in the gorges at the head of the tributaries of Cedar Creek, and the lavas which outcrop in that locality can be traced right round through the south of the basin to the Greylands property.

Some irregularities in the general disposition of the successive units or zones in this basin are apparent from a study of the rocks in the neighbourhood of Wells Mountain. Here there is a northerly trending projection or lip of the basin which dominates the arrangement of the strata. The top of Wells Mountain is a felsitic lava which forms an outlier on account of the gentle dip in that area. Such structures are not common in the Carboniferous belt in the Lower Hunter because the dip of the beds, in general, is sufficiently large to give continuous outcrops. Even upon the Wells Mountain end of the basin there is a further irregularity in the shape of an anticlinal bulge which occurs in Portion 111, Parish of Herschell.

The effect of the Brushy Hill fault in the central part of the area has been to conceal the lower beds of the Owens Mt. Basin, and also to hide from sight the zone where the beds turn over and resume the north-easterly dip, which is maintained in the main northern belt.

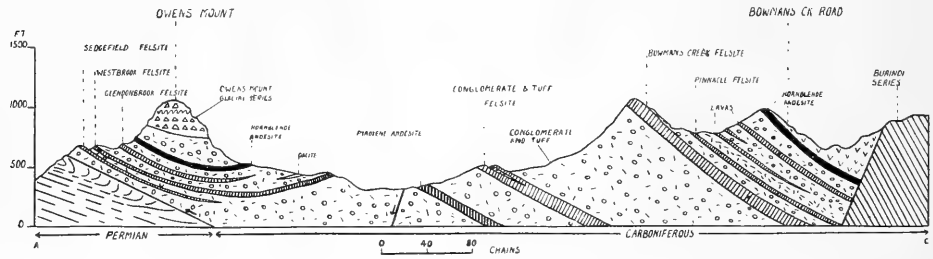
On the north-western part of the area mapped the trend begins to turn from NW. to NNW. and in the neighbourhood of "Albano" Station, in the southern portion of the Parish of Tudor, the rocks are striking almost due north and south.

The remarks upon the structure made in the foregoing paragraphs are almost wholly applicable to the Kuttung Series, but the same general trends are seen in the Burindi rocks, and this just emphasizes the conformable relationship between the two Series. The two areas of Burindi rocks are found in between the Kuttung provinces as a result of strike and oblique faulting. One area in the neighbourhood of Yellow Rock, at the head of Muscle Creek, shows a variation in the direction of trend from N. 50° W. near Yellow Rock to due north near Fishhole Creek. A corresponding change is seen in the directions of strike in the Kuttung rocks which are adjacent to the Burindi rocks at each locality.

On the north-east of the area, in the Campbell's Creek-Goorangoola region, the Burindi terrane possesses a steeper dip than the associated Kuttung Series, but the strike is about the same in all places, except in one small area. Indeed, on the northern end of Razorback Ridge where the Goorangoola fault has become a dip fault, it is difficult to separate the Carboniferous series, as the dip values are about the same.

Structure-Section along Line ABC on map (Text-fig. 5).

The section along the line ABC crosses the central portion of the area in a general northerly direction. It begins on the Permian sediments in Portion 23, Parish of Liddell and, after a short distance, crosses the Hunter overthrust fault. The Volcanic Stage beds are then traversed along a series of dip escarpments and ridges until the central zone of the Owens Mt. Basin is reached, where the Glacial

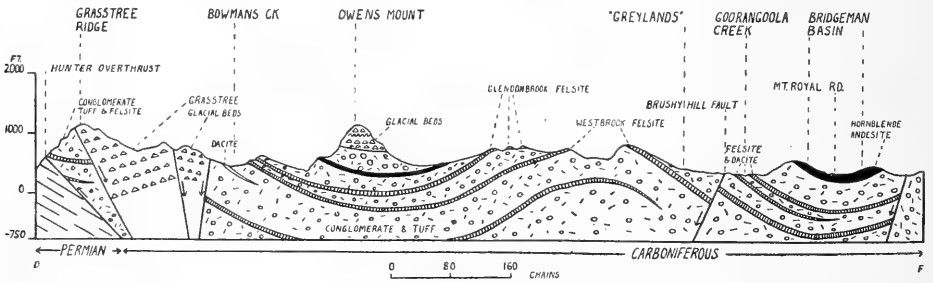


Text-fig. 5.—Line ABC on Map.

Stage is seen. There is evidently a certain amount of asymmetry in the basin because the basal conglomerate is much thicker on the southern side than on the northern side. Passing along the left bank of Bowman's Creek the beds are dipping south, until the Brushy Hill Fault is reached. This throws to the south-west, and immediately to the north of it the beds are found dipping to the north-north-east, and a long sequence, starting with the pyroxene-andesites, now begins, running through the Volcanic Stage to the hornblende-andesites near the Bowman's Creek road, and beyond through the Lower Portion of the Glacial Stage to the Goorangoola Fault. This fault also throws to the south-west, bringing Burindi rocks on the north-east against Kuttung rocks. The Burindi Series is dipping fairly steeply in Campbell's Creek, but flattens out somewhat to the east. The section ends in the Burindi rocks which continue beyond the limit of the map.

Structure-Section along Line DEF on map (Text-fig. 6).

This section is very instructive, as it passes over the disturbed region in the environs of Grasstree Trigonometrical Station, and also shows the relation of the Bridgeman and Owens Mount Basins. After crossing the Hunter overthrust, lavas and conglomerates of the Volcanic Stage are seen. These are faulted and jointed strongly, but only the major faults are shown on the map and section. The hills

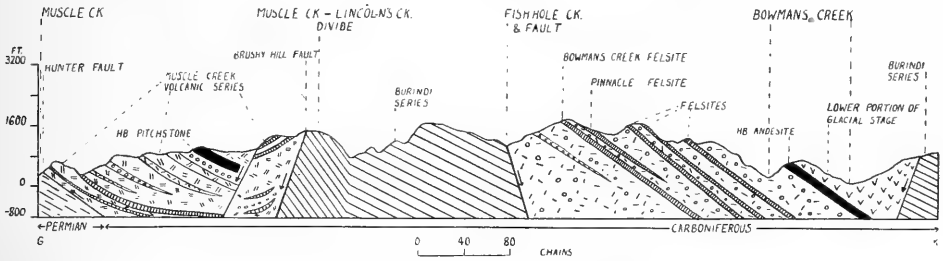


Text-fig. 6.—Line DEF on Map.

round about Grasstree form a senkungsfeld type of structure. There is a strong fault throwing to the north-east, and then, after passing over some glacial beds for one and a half miles, another fault throwing in the same direction is seen. The glacial beds still outcrop for some distance to the east, and then the third fault, which forms the eastern side of the senkungsfeld is encountered. Beyond this there are beds of the Volcanic Stage, which give characteristic topography, the Glendonbrook felsite in particular forming a very decided line of hills. The top of this Stage is reached at the hornblende-andesite and the Glacial Stage leads up over Owens Mount, and down to the eastern side, where the basal conglomerate of the Stage is very coarse. After crossing the eastern andesite, the line of section changes a little and carries along obliquely to the strike, traversing the Greylands property and crossing the anticlinal bulge which is the complementary structure joining together the Owens Mount and Bridgeman Basins. This pitching anticline is most prominent a little to the north of Dawley's Gully. Further on there is the flat land on the right bank of Goorangoola Creek, and under the alluvium of this stream is the Brushy Hill fault, which here is just near its point of initiation, the throw being relatively small. To the east a series of lavas, more or less equivalent to those on "Greylands", are seen in the creek beds and then the western side of the Bridgeman Basin is reached. This basin has been described in an earlier paper.

Structure-Section along Line GHK on map (Text-fig. 7).

An instructive traverse is that along the line GHK, because it takes in the horst-like mass of Burindi rocks near Kangaroo Mountain, and crosses four normal



Text-fig. 7.—Line GHK on Map.

faults, three major ones and a minor one. Starting near the junction of Beggary Creek with Muscle Creek, after leaving the Permian system, the Muscle Creek Volcanic Series is passed over, a small fault being crossed near the head of Muscle Creek. This fault has cut out some of the Volcanic Stage units and turned up the lower members, so that they now dip against the main series at a steep angle. The fault is parallel to, and much smaller than, the Brushy Hill fracture which cuts through just near the divide between Lincoln's Creek and Muscle Creek. From here across to Fishhole Creek, there is a region of rough country occupied by lavas, conglomerates, tuffs and limestones belonging to the Burindi Series. Fishhole Creek is just along the line of the fault which bears the same name, and this dislocation has brought the Volcanic Stage down against the Burindi beds. After a climb out of Fishhole Creek, one reaches the prominent ridge along which the bridle-track from Bowman's Creek Village to Davis Creek proceeds. About five miles brings one to the top of the Volcanic Stage and then, after some repre-

sentatives of the Lower Portion of the Glacial Stage have been passed, the Goorangoola Fault is reached, with the Burindi Series outcropping immediately to the north-east.

Faulting.

The Hunter Overthrust.

It is proposed to give the name "Hunter Overthrust" to the great thrust fault which separates the Carboniferous and Permian systems between Scone and the Maitland district. This fracture zone includes the Lachnagar fault of the Gosforth-Stanhope area, and therefore that part of the Lachnagar fault near Brooks Mountain which was originally called the Elderslie fault by Professor David.

The Hunter Overthrust has been described for the Sedgefield-Glendonbrook area (Osborne, 1926) under the name of the Bridgeman fault, and many of the features displayed in that region are repeated in the Muscle Creek-Glennies Creek area. The outcrop of the fault swings along two major directions, namely north-north-west and west by south, except near Grasstree where the trend is about due north for some distance. This outcrop, as indicated on the map, emphasizes strikingly the attitude of the fault-surface. At times it is dipping in a certain direction, and at other times the direction of inclination has changed. The amount of dip varies a good deal, and it is very difficult to determine its value with any degree of accuracy. However, in the neighbourhood of the head of Mundawah Creek, in Portion 127, Parish of Dyrring, some observations made regarding the heights above sea-level of a number of points which were, as far as could be determined, on the fault line or very close to it, led to the conclusion that the dip of the thrust in this region was of the order of 28-30°. Further to the west, in the present area, in Portion 181, Parish of Goorangoola, there is a splendid opportunity for seeing the general nature of the dip of the overthrust. Here there is a hill, sloping to the north, which is capped by a Kuttung felsite, but composed in its lower part of sediments of Permian age, and the junction between the two units, i.e. the overthrust plane itself, is seen to be almost parallel to the dip in either system, the uniform dip for all the structures being 18°, so that here we have evidence of the thrust lying fairly flatly.

A little to the north and north-east of Antiene there is a group of hills which stand up out of the lower ground, reaching a maximum height of 1,200 feet above sea-level. The general relationships between the Kuttung and Permian rocks here have been determined after careful examination, but, owing to the complexity which is brought about by faulting, one is not able to interpret the full meaning of the associated features concerning the structure in this locality. It is clear that the felsite lavas that are found below the main eminence, as, for example, in Portions 140 and 161, Parish of Liddell, belong to the Carboniferous system, as they are continuous with the felsites further to the east. However, in order to allow for the inclusion of these in the Kuttung province, and with due regard to all the other data, it is necessary to postulate an irregular scoop-like depression in the fault surface. It is by no means considered, however, that this warped structure is the result of folding of the fault plane, but it is believed that in the fracturing along the great overthrust an irregularity occurred in this locality, which has produced the feature as we see it to-day.

No very satisfactory result has come from a consideration of the question of the throw of the overthrust. There is plenty of information as to the strati-

graphical differences implied by the outcrops in juxtaposition along the fault, but this is of little importance, because no very great vertical displacement associated with a large lateral displacement, might bring in close association beds which are separated by a great stratigraphical interval. It is of general interest, perhaps, just to record that the maximum stratigraphical throw is of the order of 13,000 feet. A factor which has tended to increase the difficulty in estimating the true throw of the overthrust is that the Permian beds have been turned over in front of the overriding crust-flake, thus showing in many places a dip which is in harmony as regards both direction and amount, with the inclination of the fault surface. Thus any units in the Permian System which have responded to such dragging cannot be used as datum beds with which to analyse the faulting and arrive at a measure of the vertical component of the movement.

The Hunter overthrust outcrops frequently at the foot of a ridge, the higher country being given over to the Carboniferous terrane and the more subdued country to the Permian rocks, and in general one can pick out the boundary of the two systems by the line of the highlands. At other times, however, erosion has reduced a considerable amount of the Kuttung Series adjacent to the fault, and the trace of the latter outcrops some distance in front of the receding scarp of the Carboniferous highlands. Again, in other cases, the junction between the two systems occurs up on the side of some hill or ridge at a considerable height above the general level of the lower ground. At Antiene, for example, in Portion 69, Parish of Savoy, the fault outcrops at a height of 1,000 feet above sea-level and hard Permian sandstones and conglomerates form part of the western and southern portions of the Grasstree ridge.

The Normal Faults.

These comprise one very important set which all possess a fairly steep dip and a general strike in a north-westerly direction. The greatest variation between the strikes of any of the faults in this series is 15°. In addition to this system there is a strong fault trending north and south, which is cut off by one of the former set, and it is considered very probable that this fault is of the same general age as the others.

Then there is a second and less important series which embraces an interesting fault occurring to the south of Owens Mount, and a group of small faults near the Bowman's Creek road. These are all parallel to the second of the two trend lines mentioned under the description of the folding of the area, and make an angle of about 65° with the general strike of the first series.

First Series of Faults.

Brushy Hill Fault.

This fault has been so-named by the writer because he has traced it from its beginning near "Greylands" homestead right through the Carboniferous belt to the neighbourhood of Brushy Hill Range, east of Scone, a distance of 30 miles. It runs along the foot of Brushy Hill and crosses the Scone-Belltrees road at a point about 7½ miles from Scone. The name selected was decided upon because the locality of its occurrence to the north is well-known, and the fault is really responsible for the formation of Brushy Hill Range, and further because there was no suitable and well-known locality-name available along its course to the south-east.

The details of the geology where the fault crosses the Scone-Gundy road, are the subject of current investigation by Mr. C. A. Sussmilch. The behaviour of the fault from the head of Muscle Creek to the Scone road will be dealt with in a forthcoming paper by the writer.

The great interest of this fault is that its beginning can be clearly interpreted. It commences in Portion 9, Parish of Goorangoola, and trends N 20° E. Investigations show that the fracture carries on a little to the north to a point just opposite the "Greylands" homestead, where a second fracture begins and with the other forms the north-east corner of a block of the earth's crust which has sagged down and fractured back as far as the Portion 9 mentioned above. The second fracture, which is really the fault proper, trends in a north-westerly direction.

There is evidence of displacement along the first fracture and the effect of the downward movement of the corner of the block can be seen in the attitude of a felsite lava which outcrops on the small hill on the eastern side of the road just opposite the "Greylands" gate, and dips steeply to the south-west. That the main fracture does not continue beyond to the south-east is absolutely definitely established by a knowledge of the outcrops occurring in that region.

The throw of the fault at the corner where it begins upon its main trend is approximately 600 feet, but it increases rather noticeably and near Bowman's Creek the throw is about 3,000 feet. The fault is essentially a strike fault because it duplicates the Volcanic Stage belt and is almost entirely parallel to the strike of the rocks in the northern belt, although it cuts across the subsidiary fold-trend in the southern belt of the Volcanic Stage. The dip of the fault is fairly steep, being probably about 75° between "Greylands" and Muscle Creek, but thereafter the fault surface changes its inclination, becoming less steep. It can be traced fairly readily because of the striking effect it has had on the stratigraphy, and also because of the fault-evidence present in a number of places in the shape of breccia and jointing along the zone of fracture, and upending of the strata in the vicinity of the fault-line. In particular, one sees some of these effects at a point on the right bank of Bowman's Creek in Portion 76, Parish of Herschell, where a lava has been sharply truncated and jointed. Also to the west of "Greylands" in Portion 387, Parish of Goorangoola, there is jointing and brecciation in the tuffs and associated lava.

From the head of Sawyer's Creek (Parish of Herschell) to the limit of the area mapped the Brushy Hill fault forms the boundary between Burindi and Kuttung rocks, and near the divide between Lincoln's Creek and Muscle Creek, on the bridle-track which runs close to the fault, there is much clear evidence of movement in the fractured and upturned sediments in the Burindi Series, and again in Portion 319, Parish of Balmoral, where further evidence is seen in the local high dip to the south-west shown by some of the Muscle Creek Series.

The Goorangoola Fault.

The Goorangoola fault has been mapped from the Razorback Ridge in the southern part of the Parish of Liebig to the head of Bowman's Creek, a distance of seven miles, and at either end of the line the fault still continues strongly. The dip is at about 50° to the SW., the trend or strike being practically the same as that of the main part of the Brushy Hill fault. The Goorangoola fault throws the Kuttung Series against the Burindi Series, but there are not sufficient data from which to calculate the true throw, and it is doubtful if such will ever be possible,

because the stratigraphy of the Burindi Series is obscure in this locality. However, it is possible to place the minimum value of the throw at 6,000 feet. In the western part of the area considered the strike of the fault parallels that of the two series, but in the more easterly portion of the Razorback Ridge it is a true dip fault. Here it is difficult to draw the line between the Kuttung and Burindi Series, and this in spite of the fact that the latter rocks are fossiliferous. The difficulty arises because of the similarity in appearance of the soils derived from the calcareous tuffs of the Burindi Series, which only contains restricted fossiliferous horizons, and the tuffs of the Kuttung Series, and also because of the prevalence of talus material and scrubby undergrowth.

The Grasstree Faults.

There are three main faults near the Grasstree Trigonometrical Station and the ridge southward therefrom, which may be called Grasstree faults No. 1, No. 2, No. 3. In addition there are other small faults but their relations are not clear.

Grasstree fault No. 1 is traceable right across the ridge from Portion 89, Parish of Herschell, to the place where Bowman's Creek leaves the Carboniferous hills, the fault being truncated at either end by the Hunter overthrust. The strike is N 50° W and the dip steep to the south-west. The effect of the fault has been to throw down the Glacial Stage below the level of the Volcanic Stage. The throw is not definitely known but is between 2,000 and 3,000 feet. Along the fault there is a zone of brecciation which has involved some of the varve-rocks.

The No. 2 and No. 3 faults lie a little to the south-west of the No. 1 fault and appear to unite near the Bowman's Creek gap, in Portion 4, Parish of Herschell. The former of the two throws to the south-west and the other to the north-east. Each possesses a strike more or less parallel to the trend of the larger faults in the main fault-series. The No. 3 fault is the greater one and has set the Glacial Beds against the Volcanic Stage. The manner in which this fault has truncated various horizons in the Kuttung Series is very striking (see map). Associated with this fault are a number of small dislocations, some of the effects of which can be seen in the steep gullies on the south-west side of the Grasstree Ridge. The limit of the No. 2 fault to the north-west cannot be determined completely, but it is shown as far as it could be traced. In connection with these faults in this particular locality there is the problem of fitting in the pyroxene-andesites to the west of Grasstree Trigonometrical Station. These rocks are fairly low down in the Volcanic Stage and are probably separated from the rocks just to the north-east by another fault which is not shown on the map because its position could not be definitely determined.

Second Series of Faults.

An interesting fault occurs to the south of Owens Mt., which is cut off at either end by the Hunter overthrust. This fault strikes E 5° N and is practically vertical. It has thrown down the Glacial Stage rocks against the lower part of the Volcanic Stage, and the former are now lying with a very steep dip. A strong mass of glacial conglomerate in this downthrown block makes a dominant line of "whale-back" outcrops running east and west (see map). This fault is essentially parallel in trend to the axis of the Owens Mt. basin. Also conforming in general to this axis are some small faults which cut across the hornblende-andesite in the neighbourhood of the Bowman's Creek road in the Parish of Foy.

Other Faults.

Fishhole Creek Fault.

This is a normal fault with meridional trend, which occurs near the head of Sawyer's Creek and runs along Fishhole Creek for a distance of four miles. It is cut off to the south by the Brushy Hill fault and must antedate it, as will be explained below. It serves to bring the Burindi Series against the Kuttung, and in Portion 33, Parish of Herschell, one can see in the right bank of Fishhole Creek fossiliferous mudstones, and on the other side of the stream, at the same level, the Kuttung rocks. The strike in the two series is constant, but the Burindi beds are dipping more steeply than the Kuttung beds. The divergence in trend between the Fishhole and Brushy Hill faults brings about an increase in the area of the Burindi rocks as one goes north-west, and after extending beyond Kangaroo Mountain the Burindi province swings away towards Rouchel Brook and the Upper Hunter River.

An interesting fault which does not quite agree with any of the others in strike, although not very far removed from the trend of the second series, occurs near Dawson's Hill. This cuts across the hornblende-andesite a little to the west of the Dawson's Hill Post Office. It has a throw of about 600 feet and dips at an angle of 45° in a direction N 40° W. Its presence is indicated very clearly by the outcrops of the andesite, and by the existence of a fault breccia and a zone of intense splintering and jointing.

Relation of the Faults to each other and to the Folding.

The folding described above is continuous with that observed in the Carboniferous belt from Singleton to the eastern coast. The age of this folding has been shown by Professor Sir Edgeworth David to be late Palaeozoic. It has produced two sets of trend-lines in the area under discussion, and it has been found that the two main sets of normal faults possess trends which are essentially parallel to the directions of the fold axes.

In the areas to the south-east and east the systems of normal faults which cut through the Carboniferous and Permian terranes are genetically related to the folding, because in some cases a fold passes into a fault and also because the Triassic rocks occurring south of the faulted Permian province show no effects of the faulting.

As shown by the writer in earlier papers, the normal fault-systems show trends parallel to the axes of the late Palaeozoic folds, and the results of an analysis of the folding also indicate that the faults are almost certainly of the same general age as the folds.

In tracing the Carboniferous structures from the Lower Hunter Valley towards the north-west the same relationships between the normal faults and the folding are found to exist. Further, many of the normal faults in the Carboniferous areas are truncated by the Hunter Overthrust, which, from a consideration of the geological history of the Hunter region, appears to be post-Palaeozoic but pre-Pliocene in age.

Thus it is considered that the more important normal faults in the Glennies Creek-Muscle Creek region represent fractures which developed in the tensional stages following the periods of compression. In the present region there were two phases of compression and two corresponding periods when tensional conditions obtained, and during the latter the respective sets of faults developed.

There are one or two small faults which do not fit in with the tectonic lines of the late Palaeozoic diastrophism, and the age of these is a matter of doubt.

What has been said above provides for all the large faults, with the exception of the Fishhole Creek fault. An examination of the relations of this fracture shows that the area of Kuttung rocks to the east of Fishhole Creek has moved downwards a considerable amount. But this area is part of the northern belt of Volcanic Stage rocks which form the upthrow-block of the Brushy Hill Fault.

Thus it is seen that the Fishhole Creek fault cannot be a branch of the other fault. And as it does not fit in with the trend of either fault-series we must conclude that it represents a displacement connected with the late Palaeozoic folding, but of earlier formation than the other series of fractures.

The normal faults considered above do not pass into the Permian System, as far as one has been able to make out, but on the other hand where a strong fault in the Carboniferous System is striking for the Permian terrane, it becomes cut off along the line of the Hunter overthrust. This suggests that this overthrust is post-Palaeozoic, and there seems little doubt of this when one considers the contrast between the features of the late Palaeozoic folding and faulting, and the character of the overthrust. The exact age of the thrust is not yet known, but further work to the north will gradually throw light upon this question.

Brief Account of the Salient Physiography.

The area as a whole has been widely dissected since the Kosciusko uplift at the beginning of the Pleistocene so that the general aspect is that of late-maturity, except in the head-water portions of some of the streams where almost youthful topography may be seen, and again where hard bars cross the course of the streams producing features not normally associated with a mature landscape. The divides between some of the larger creeks are very narrow, as for example that between Muscle Creek and Lincoln's Creek.

Most important among the facts derived from a general study of the physiography is the conclusion that the area behaved as one unit in the uplift at the close of the Tertiary Period in New South Wales. There are no faults in the area, with perhaps the exception of one insignificant one, which are not older than the peneplanation that preceded that uplift. All the faults have been revealed during Pleistocene and present erosion, and one can see remnants of the plateau formed at the Kosciusko uplift in the eminences which occur in a number of places throughout the area, for example, Kangaroo Mountain (2,307 feet), Grasstree Trig. (1,725 feet), Wells Mountain (1,941 feet), and others. The differences in elevation of these hills are not due to the presence of late-Tertiary faults produced during the last great uplift, since careful mapping has proved the absence of these. On the other hand one can see in the varying heights of the eminences between Bells Mountain (Muswellbrook district) and the Paterson Region, and even beyond, definite evidence of a general tilt in the plateau surface which was produced by that uplift. A splendid view of the remnants of this tilted surface is obtainable from a low hill in Portion 66, Parish of Greta, between Allandale and Harper's Hill.

The main streams in the area are Glennies Creek or Fal Brook and Bowman's Creek or Foy Brook, both of which belong to the Hunter Drainage System. The eastern part of the area is drained by the former and its tributaries, the chief of which is Goorangoola Creek. The central portion of the area is drained by the latter, which possesses important tributaries in Cedar Creek and Lincoln's Creek. The chief stream in the west of the area is Muscle Creek.

The general trend of the main streams in the central and eastern portions of the area is a little west of south, but there do not appear to be any structural features to account for this. On the contrary the streams cut right across the strike of the rocks. The same is the case with Muscle Creek, which, however, possesses a south-westerly trend.

Nevertheless, while the main creeks as a whole do not show adjustment to the geological structures, it is noticeable that locally such adjustment has taken place, and that some of the smaller tributaries owe their disposition entirely to such an adjustment. The fact that the larger streams do not show any definite relation to the trend-lines of the country, together with the fact that the interbedding of hard and weak units is conducive to an effective regulation of the evolution of the streams, suggests the possibility that the larger streams date back to the ancient drainage in pre-uplift times.

The degree of resistance of the various units in the Kuttung terrane varies a good deal, producing, on account of the folding present, a series of dip-escarpment ridges. What has been written for the Mirannie-Dyrring area (Osborne, 1926, p. 405) about the behaviour of the various units towards the forces of erosion, applies to the present area and thus needs no repetition. The Burindi rocks form much of the higher and less dissected ground because they outcrop in the headwater tracts of the streams.

Domestic river capture will occur relatively soon in a number of places. Thus at the head of Muscle Creek, the divide separating this stream from Sawyer's Gully is very narrow, and the former is eroding at a greater rate than the latter, whose valley trend is about at right angles to that of Muscle Creek. Again, in the area to the east of Bowman's Creek, some of the tributaries of that stream have only to erode back a short distance to capture some of the drainage which now belongs to the Glennies Creek system.

The faults as a whole have played an indirect part in the production of the present topography, and of them the Hunter overthrust has been by far the most important. In general the Permian terrane to the south-west of the fault has been rapidly eroded to form part of the broad valley of the Middle and Lower Hunter River, while the Carboniferous belt to the north-east of the fault has been much more resistant. As exceptions to this generalization we have the Permian rocks, where locally strongly resistant, as near Antiene and Grasstree, producing rough country with a maximum altitude of 1,100 feet above sea-level. The overthrust was most probably of earlier formation than the Kosciusko uplift, but the exact relations of these will not be discussed in the present paper.

Summary.

Stratigraphy.

A general summary of the stratigraphy of the Carboniferous rocks of the Glennies Creek-Muscle Creek region is as follows:—

	Greatest observed Thickness in Feet.
Kuttung Series.	
Glacial Stage.	
Main Glacial Beds	1,645
Toscanite	50
Lower Portion	1,600
Volcanic Stage	4,795
Burindi Series	1,800
	9,890

It is not proposed in the present communication to discuss the relation of the stratigraphy of this area with that of the areas to the south and south-east, as this will be done when a greater portion of the Carboniferous belt is under review.

Tectonic Geology.

The most important aspects of the structural geology may be listed as follows:—

1. In late Palaeozoic times the Carboniferous rocks were broadly folded with a general north-westerly trend, and cross-warped in an east-north-east direction.

2. This folding produced Owens Mount Basin and a flatly-pitching anticline in the central southern portion of the area, and elsewhere arranged the Kuttung Series so as to lie in a general belt-like fashion, dipping to the north-north-east and north-east.

3. The area was strongly faulted during two periods of crustal activity. In the late Palaeozoic diastrophism two sets of normal faults were produced. each series having a trend respectively parallel to one of the two trend-lines in the folding. The major of these two sets of faults includes the Brushy Hill fault, the Goorangoola fault, and the Grasstree faults. Again, at a much later period the Hunter Overthrust developed, slicing through the Upper Palaeozoic rocks and pushing the Carboniferous rocks over the Permian terranes. The general direction of the movement in this case was from the north-east towards the south-west.

4. It is probable that peneplanation intervened between the two sets of movement mentioned in the last paragraph.

5. Following the Hunter thrust the whole of the area was reduced to a peneplain at the close of the Tertiary Period, and ultimately epeirogenic uplift ushered in the Pleistocene erosion-cycle which is still in progress.

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PLATE XXXVII.

Geological map of the Carboniferous System between Glennies Creek and Muscle Creek, Hunter River District.

THE CARBONIFEROUS ROCKS IN THE MUSWELLBROOK–SCONE DISTRICT, WITH SPECIAL REFERENCE TO THEIR STRUCTURAL RELATIONS.

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(Plate xxxviii and two Text-figures.)

[Read 28th November, 1928.]

Preliminary and Geographical.

The Carboniferous rocks between Muswellbrook and Scone outcrop in a belt running in a more or less meridional direction. To the south-east of Muswellbrook these rocks continue to the Lower Hunter area, while further north than Scone, they can be traced with ease right into the northern part of the State, and even to the Queensland border.

The area considered in this paper is a direct continuation of the area described in a recent paper (Osborne, 1928), and begins on the south-east at Muscle Creek and ends on the north at the Scone-Upper Hunter road. Between these limits the Carboniferous area is divisible into two main parts, the western division being composed of Kuttung rocks, and the eastern part consisting of the Burindi Series.

The western boundary of the Kuttung Series, for almost the entire extent of the area, is the Hunter fault, a great overthrust against which occur the Permian rocks. The eastern boundary of the Kuttung belt is also a fault which, however, is normal in character. This is the Brushy Hill fault which has thrown the Kuttung Series down against the Burindi Series. The Burindi rocks outcrop right to the eastern margin of the area and their limit in that direction has not been determined.

The Carboniferous rocks are responsible for a line of highlands which includes Bells Mountain, east of Muswellbrook, Colonel's Mount, east of Aberdeen and the Segenhoe Hills between Pages River and the Great Northern Road.

The Permian rocks on the west of the Kuttung belt have been eroded extensively by the Hunter River and its tributaries, and northward from Muswellbrook the main valley of the Upper Hunter, with its chief tributary, Pages River, is found crossing the Carboniferous rocks, and to the north-east of this locality, the Carboniferous and Devonian rocks have suffered extensive denudation by these streams.

One notable exception to the general rapid removal of the Permian rocks is the preservation of a residual ridge which trends north between Muswellbrook and Aberdeen. This ridge is composed of conglomerates and sandstones containing plant stems.

Where the Upper Hunter and its main tributary flow out from the Carboniferous area and enter the broad valley down-stream from Segenhoe, there is a

marked gap in the Carboniferous highlands, and much alluviation has taken place up-stream from this point.

There is evidence of valley-in-valley structure between Scone and the districts east and south-east therefrom, but the details of the physiography have not been worked out by the writer. One important point bearing upon the physiography of the present area is that there is no late Tertiary or Pleistocene faulting to account for the marked differences of level which exist in the region.

One outstanding feature about the western and northern portions of the area under description is the prevalence of a heavy mantle of soil and drift, some of which is thirty feet deep. Much of this obscures the Palaeozoic terranes and the most critical area, from the point of view of fault relationships, is covered in this manner.

Large areas in the region are cleared and the geological relationships in such places are relatively easy to determine, but in other districts, notably on Bells Mountain and on Colonel's Mount, the prickly-pear growth is so great that the investigation of the rocks is practically impossible.

The chief purpose of this paper is to consider the structure of the Carboniferous belt, particularly the portion of the belt composed of Kuttung rocks. The stratigraphy will be considered only in a general way, because the area immediately to the south has been fully described and the same general features are shown by the rocks in the area now under discussion.

Very little geological observation has been carried out in this area in the past. J. E. Carne (1914) recognized the existence of a faulted junction between the Permian and Carboniferous systems near Muswellbrook, and reference to this fault was also made by Professor David (1914). Descriptions of Lower Carboniferous fossils in the Burindi Series along Rouchel Brook have been given in publications issued from time to time by the Geological Survey of New South Wales, and these occurrences have been discussed in a very useful paper by Benson (1921). Brief mention has also been made of some of the structural features of the Carboniferous and Permian rocks, particularly near Scone and Wingen, by W. R. Browne (1924). In a number of papers dealing with the physiography of the Hunter Valley (Taylor, 1906, 1911; Andrews, 1914) very brief reference is made to the area considered in this paper.

Summary of Lithology and Distribution of the Carboniferous rocks.

Burindi Series.

The Burindi rocks, of Lower Carboniferous age, which occur between Muscle Creek and Fishhole Creek in a horst-like mass, extend northward, increasing in extent until wide areas along the Upper Hunter Valley are occupied by them. The general structure in the Burindi belt is simple, consisting of a dip to the north-east and east-north-east, the degree of inclination varying a good deal. In this dipping belt there is a series of sediments and occasionally some lavas. The sediments embrace limestones, with a typically Lower Carboniferous fauna, tuffs, calcareous sandstones, shales, mudstones and conglomerates. The limestones are sometimes markedly oolitic, and particularly good examples are to be seen along Brushy Hill range and in portions 15 and 42, Parish of Russell. A very distinct belt of limestone outcrops at Yellow Rock and runs through the gap east of Colonel's Mount and on to Brushy Hill. Where the Burindi rocks consist of calcareous tuffs, the erosion has been very extensive. The limestones, on the other hand, stand out fairly well and help to make some of the rugged country

which occurs between Sandy Creek and Rouchel Brook, where also there are some lava flows.

In the area mapped, a minimum thickness of 3,000 feet is indicated, but considering the extension of these rocks to the east, it is clear that the series must be very thick in this part of New South Wales.

Kuttung Series.

Situated between the Hunter Overthrust and the Brushy Hill Fault lies the Kuttung belt. This division comprises rocks belonging to the Volcanic and Glacial Stages of the Series, but it has not been possible, except near Scone, to determine definitely the extent of each stage, nor was there time to determine the details of the stratigraphy. This, however, is hardly necessary, as the general facies of the two Stages are very similar to those described for the Muscle Creek-Bowman's Creek area. In the paper dealing with the last mentioned district, it was shown that the Volcanic Stage near Muscle Creek showed features that were distinct in many ways from those of the Volcanic Stage in the areas further to the south-east. This facies, typically shown in the Muscle Creek section, is continued in the rocks on Bells Mountain and on towards Segenhoe, especially in the low hills along the neighbourhood of the Rouchel Road and between the Hunter River and the line of the Hunter Overthrust.

In the cuttings on the Rouchel Road there is a prevalence of felsites in the Volcanic Stage, many of which are devitrified dacites, and there is an almost complete absence of the andesitic types.

The conglomerates associated with the lavas are well sorted, containing boulders up to seven inches in diameter set in a tuffaceous matrix that weathers to produce a good soil. Sometimes the conglomerates, and the tuffs also, are very calcareous, due to the infiltration of lime-bearing solutions probably derived from the Burindi areas to the east.

The Volcanic Stage makes up all the Kuttung terrane north of Colonel's Mount, with the exception of the central portion of the Segenhoe syncline.

On Bells Mountain and Colonel's Mount the Volcanic Stage and the Glacial Stage are mixed up by minor faulting and it is almost impossible to do much in the elucidation of the relationships and extent of these rocks because of the prickly-pear growth.

Between the point of confluence of the Hunter River and Rouchel Brook and Scone, the thickness of the Volcanic Stage is approximately 3,500 feet. Most of this thickness is made up of volcanic material, the conglomerates being subordinate.

The Glacial Stage comprises tillitic conglomerates, normal conglomerates, sandy tuffs, varve-rocks and occasional interbedded felsites. The best place to study these rocks is in the central portion of the Segenhoe Syncline, particularly along Bullock Creek. They also occur on the divide in the gap between Sandy Creek and Rouchel Brook, in portion 173, Parish of Balmoral, near the head of Muscle Creek, and on the north side of Bells Mountain along the Sandy Creek road.

Two horizons of varve-rock have been noted in the Glacial Stage, one outcropping on the Sandy Creek Road and the other on the track from McCully's Gap to Rouchel Brook Road. The former unit possesses a very characteristic grey body-colour with darker layers, almost black in colour, which represent the summer accumulations in the deposit.

A section through the upper part of the Volcanic Stage and the lower part of the Glacial Stage is exposed along Sandy Creek. This section may be generalized into the following summary, descending stratigraphically:—

	Thickness in feet.
Banded felsite	50
Pink tuff	150
Felsite	200
Conglomerate and tuff	500
Varve-rock	80
Acid tuff	75
Pebbly sandstone	50
Cherty tuff	100
Conglomerate	150
Coarse tuff	60
Conglomerate	150
Toscanite	50
Tuff	250
Green felsite	280
Tillitic conglomerate and tuffs	500
Felsite	100
Tuff	90
TOTAL	2,835

STRUCTURAL GEOLOGY.

Folded Structures.

The result of the late Palaeozoic folding in the present area is the existence of a number of broadly warped structures on the west and a general tilting on the east. The dip of the Kuttung Series at Muscle Creek is to the north-east, and this continues to the vicinity of the Brushy Hill fault, where there are reversals. Beyond the fault the Burindi rocks show the same general north-easterly dip, and these marine rocks maintain this direction of dip fairly constantly to the Scone-Gundy road. In the Kuttung Series there is much more variation in the structure.

Bells Mountain is seen to be a very flat basin-like structure, the angle of dip of the rim being as low as five degrees in places. This depression is connected with the simply-tilted mass of Kuttung rocks running up Muscle Creek by a warp in the Volcanic Stage. It is also connected with another flat basin-like depression on Colonel's Mount by a plunging anticline trending along Sandy Creek. The Bells Mountain structure is disturbed by steep minor faulting at the north-western end, and is eventually cut off altogether by the Hunter Overthrust. One can see the structure clearly delineated by the outcrop of a very conspicuous unit of conglomerate which gives rise to a series of bluffs on Bells Mountain and Colonel's Mount. There is also an outstanding felsite near the head of Rainbow Creek which acts as a good indicator horizon.

Colonel's Mount consists of a structure very similar to that on Bells Mountain. The synclinal disposition on the former, however, is more pronounced through the dips being high, in comparison with those of the latter area. The northern side of Colonel's Mount shows the passing of the synclinal structure against the Hunter Overthrust and the development of a flat anticlinal bulge which links up with the Segenhoe syncline. This syncline comprises the remainder of the Carboniferous area northward from the Rouchel Road and westward from the Hunter River. The topography has been very definitely influenced by the arrangement of the Kuttung rocks in this syncline. Thus there is a series of dip-ridges

flanking the area of the syncline, and in the central portion of the structure a region of less-marked physiography, due to the presence of the Glacial Stage rocks.

On the accompanying geological map the general plan of the syncline is made apparent by the line of dips, and it is seen that there is an irregular warping on the eastern side, producing a pronounced irregularity in the general basin-structure. It should be noted that, while the Hunter Overthrust is responsible for turning up the Kuttung strata in certain parts of the area, so as to give these a local dip to the east, in the Segenhoe area the thrust is dipping flatly and there is clear evidence that the synclinal structure was original in the Kuttung terrane.

It is possible to link up the strata on either side of the Hunter and Pages Rivers near Segenhoe, in spite of the abundance of alluvium along these rivers and particularly near their junction. Certain of the felsites are distinctive and can be traced across the alluvium, indicating that there is no great displacement, if indeed any at all, along the region of the confluence of these streams. This is a very important point, as one might easily consider, from a cursory examination of the outcrops, that there was displacement of the beds and of the Hunter Overthrust hereabouts. The great sweep of the boundary between the Carboniferous and Permian systems is due to the fact that the fault is very gently inclined and the Hunter-Page erosion has been extensive.

Superimposed upon the syncline there are at least two anticlinal variations, one to be seen near Segenhoe Trigonometrical Station, and the other to the east of Bullock Creek. The first of these is a small flat variation which is clearly manifested in the outcrop of the main felsite lava in the Volcanic Stage. The other anticline runs more or less east and west, producing a ridge which serves to limit the Glacial Stage outcrops near the head of Bullock Creek.

The north-western end of the Segenhoe syncline is interrupted by the Wingen fault, which has broken across the Kuttung rocks and duplicated some of the horizons of the Glacial Stage which outcrop in the central portion of the syncline.

The general structural features in the northern and southern parts of the area investigated are shown respectively in Text-figures 1 and 2.

Faulting.

Three important faults occur in the area and the relationship between two of these endows the region with extreme interest in connection with the problems of the Upper Palaeozoic geology of New South Wales. In addition to these three faults there are many small dislocations, all of which appear to be normal in character. Strong jointing and upturning of the strata in a number of places are the chief evidences of the existence of these smaller faults, while stratigraphical displacements are generally insignificant. In one place along Sandy Creek road there are some slickensides and polished surfaces which have been produced by minor faulting.

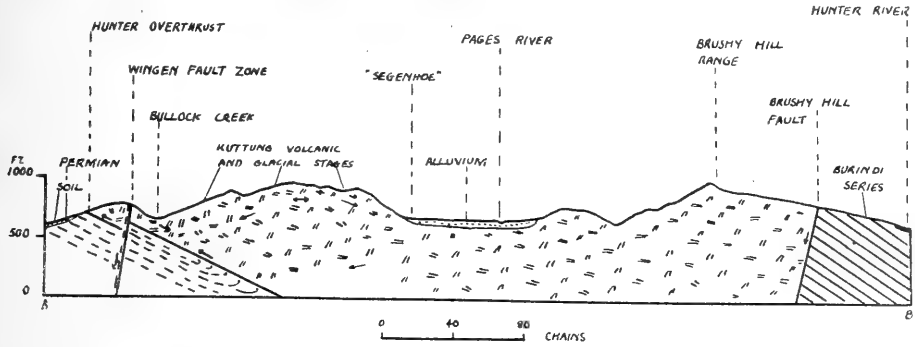
The Hunter Fault.

This large overthrust fault bounds the Kuttung area on the west from Muscle Creek to within about three miles of Scone. The fault shows practically the same essential features as have been observed in the region between Muswellbrook and Sedgefield, and a full description of the fault and its relationships has been given for these districts by the writer (Osborne, 1928).

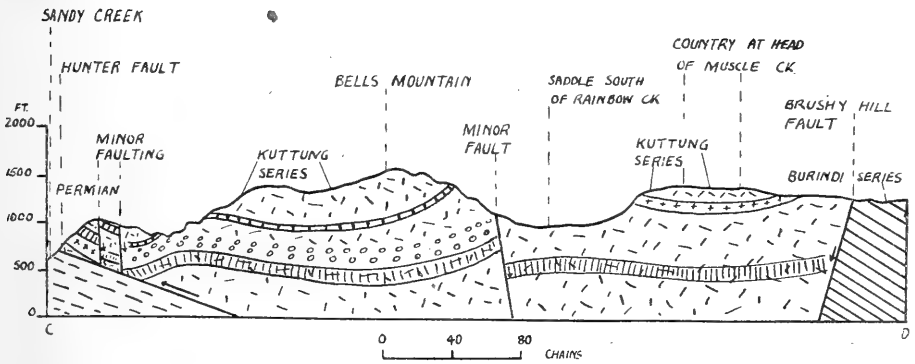
After crossing Muscle Creek the thrust runs along through some country of mature aspect and soon shows a rather sudden turn in outcrop on account of the

erosion by the large creek which leaves Bells Mountain in the northern part of portion 143, Parish of Balmoral. From this locality to Sandy Creek the fault is fairly clearly indicated and at the latter place it has placed Kuttung felsite against some thinly-bedded shales with marine fossils and associated conglomerate, these last two being Permian in age.

From Sandy Creek to the Hunter River the fault swings to the west of Colonel's Mount and its position has been placed upon the map with as much accuracy as possible, but on account of the difficulty of surveying in certain parts of the area, where prickly-pear is prevalent, some of the sinuosities in the plan



Text-fig. 1.—Line A-B on Map.



Text-fig. 2.—Line C-D on Map.

of the outcrop represent approximate positions. Near the Hunter River there is a great amount of wash and drift in which many boulders occur, and this mantle obscures the outcrop of the fault-surface. Some of these pebbles are from adjacent Kuttung units, and some represent redistributed ancient gravels of the Hunter River. It is clear that the pebbles do not constitute the product of disintegration, *in situ*, of a Kuttung conglomerate, and on this assumption the fault has been placed as shown on the map. Where the thrust is crossed by the Hunter and Pages Rivers, there is a wide curve in the line of the fault. Beyond this locality it is traceable underneath Segenhoe Trigonometrical Station and some distance to the west and then it turns so as to trend more or less meridionally. From here

to the north there is a large tract of fairly level country bounded on the west by the Main Northern Road, on the north by the Scone-Gundy road, and on the south by the Segenhoe Road. Most of this tract is covered with a thick deposit of alluvium which obscures the underlying Palaeozoic rocks. The eastern margin of this low lying country is the line of foot-hills of the Kuttung Series and it seems most probable that the fault runs along against these hills. In fact an exposure at the northern end of the region shows the Permian sandstone and tuff in close proximity to the Kuttung rocks and here the position of the fault can be fairly closely fixed. Unfortunately in the neighbourhood of the junction of the Scone-Gundy Road with the Main Road, the extent of the drift and alluvium becomes so great that it is very difficult to find any outcrops of bed-rock, and it is here that the overthrust is apparently cut off by another fault which will be described below.

The Brushy Hill Fault.

The Brushy Hill fault, which is normal in character, was first encountered near "Greylands"' when the writer was investigating the structure of the country near Goorangoola Creek and Mt. Dyrring. From that locality the fault was traced right across from Glennies Creek to Muscle Creek and its occurrence in that region was discussed in a former paper (1928). The mapping of that area carried the fault as far as the head of Muscle Creek. In the present area the fault can be followed right to the Scone-Gundy road, and at that locality it is probably of great magnitude. The details of the geology of this district are the subject of present investigation by Mr. C. A. Sussmilch. Brushy Hill range, composed of Burindi rocks, runs parallel to and at a small distance from the fracture-line as far south as portion 33, Parish of Macqueen, where the fault crosses the ridge, which is taken up in the Kuttung rocks.

The dip of the fault in the area to the south of Muscle Creek is fairly steep, but after crossing the eastern side of the depression known as "The Basin", the fracture plane takes on a less steeply inclined attitude and this accounts for the wide sweep which the fault makes to the south-west of Rainbow Creek. After crossing Sandy Creek, however, the Brushy Hill fault once again resumes its steep dip, and this is maintained right to the neighbourhood of Brushy Hill itself. In the gap between Sandy Creek and Rouchel Brook, there is very clear evidence of the existence of the fault, as there is a fault-breccia and the associated rocks are very strongly jointed and fractured into small pieces. The fault is a true strike fault and is related to the late Palaeozoic folding, as explained in the paper referred to above.

The Wingen Fault and its relationship with the Hunter Overthrust.

From Scone northward towards Blandford the eastern side of the valley of Kingdon Ponds and its tributaries is made up chiefly of Carboniferous rocks which, with cappings of Tertiary basalt, form highlands up to 3,500 feet above sea-level. The valley has been excavated out of the Permian strata which occur to the west of the Carboniferous belt and are clearly faulted against it. The writer examined this faulted junction near Scone and further north in the year 1922, and was of the opinion that the fault was a normal one with a fairly high angle of dip. At the time, it was thought probable that this fault-zone extended continuously along the Hunter Valley to the Singleton district. Professor Browne, who made a brief examination of the Scone-Upper Hunter district in 1924, described some of the

outstanding features of the geology and physiography in a short but comprehensive paper (Browne, 1924), wherein he considered one or two of the problems connected with this fault and named it the Wingen Fault. He also assumed that the fault continued along the base of the Carboniferous highlands on their western side from Wingen to Muswellbrook. However, as has been shown above, this is not the case and the overthrust separating the Carboniferous and Permian has now been examined by the present writer right along the eastern margin of the main portion of the Hunter Valley to a point situated about three miles from Scone. Here, most unfortunately, the structural relations are obscured by heavy alluvial deposits, but a careful examination shows that the thrust cannot carry on very much further, as it does not cross the Scone-Gundy road, for there is no displacement of the Kuttung rocks here. The beds on the north have not been studied in detail, but examination has been made sufficiently carefully to warrant the statement that the glacial beds south of the road are continuous with those on the northern side.

The Wingen fault, however, can be traced south from Wingen into Scone and a breccia, apparently occurring in the fault zone, is seen just south of the Scone Hospital, where also there is a Kuttung felsite outcropping right at the western margin of the Carboniferous belt. This felsite, in portion 14, Parish of Scone, shows strong jointing running in a direction S25°E and it is considered that this jointing is connected with the movement along the fault.

South of this point in the direction of prolongation of the Wingen fault there is the widespread alluvium just referred to, but about two and a half miles south-east from the junction of the Main Northern and Gundy Roads one again comes upon jointing and a fault breccia. These features are connected with a most remarkable fault-zone which runs from here towards Segenhoe Trigonometrical Station. The fault-zone can be followed between these two localities with comparative ease, except where there is some alluvium along Segenhoe Creek. The zone is excellently exposed and it would be difficult to imagine a more striking example of a fracture-zone. The examination of the rocks in the neighbourhood reveals that the fault begins some distance north of Segenhoe Trigonometrical Station (see map), because, although strong jointing is present on the small saddle just west of the Trigonometrical Station, no actual displacement is indicated until a point some distance to the north is reached.

Proceeding in that direction the amount of downthrow increases and associated with this feature is an increase in intensity of the degree of fracturing and splintering of the rocks along the zone of movement.

The trend of the joints and fracture-lines is remarkably constant, varying only to the extent of five degrees in a length of two and a half miles. The average direction which is maintained is S16°E, and where only small intermittent outcrops occur scattered through the alluvium, one finds the evidence of fracturing with the trend of the structures more or less constant. The most spectacular part of the zone is in a saddle-like area in the south-east part of Portion 16, Parish of Scone, near the divide between Bullock and Segenhoe Creeks. The fracture-zone here is about six chains in width and, beginning on the eastern side, there is a pronounced fault-breccia, which passes into a splintered zone. Then comes a strongly jointed zone, three feet wide, where the rocks of the Glacial Stage, cherty shales and varve-rocks, are jointed with almost vertical fractures into a number of elongated prismatic slabs. The disintegration of these produces a very striking apppearance, the whole zone, when outcropping along a spur or

ridge, resembling a wall-like mass standing up above the adjacent land. Westward from this jointed zone is a second mass of breccia, and then about four chains of intensely fractured rock, which on disintegration makes a shed of chips. Such sheds, with the underlying parent masses, sometimes occupy areas up to 30 or 40 feet across, thus giving rise to distinctive features which assist in tracing the fault. While not so conspicuous away from the area just described, this fracture-zone is characterized by the same general association of features, allowing it to be followed to the north, and the writer feels sure that it is the direct continuation of the Wingen fault.

Further south from the place described above, the fracture-zone is traceable along a ridge and then down a long spur leading to the large area of alluvium in Segenhoe Creek. In the small gutters through the alluvium the jointed and splintered rock is often to be seen and a small displacement is indicated by the rocks of the locality. After passing through the alluvium the jointing is seen again in the ferruginous tuffs which outcrop close to where Segenhoe Creek crosses the western boundary line of the Parish of Macqueen. Here the direction of the structures is still S16°E. Further south still, among the hills which form the high land on which Segenhoe Trigonometrical Station stands, there does not seem to be any displacement, but decided jointing is present, the dip of the joints being less steep than elsewhere. A felsite affected by this jointing outcrops on the south side of the hills, and can be seen very well from the Segenhoe road.

The author has considered the possibility of the fault zone cutting right through the Carboniferous country and displacing a portion of the thrust flake, but the evidence on the south face of the Segenhoe ridge seems to admit of no other conclusion than that there has been no displacement just there, and that the Wingen fault begins within the Carboniferous terrane and gradually increases in magnitude northward, until ultimately it drops the Carboniferous rocks beneath the Permian strata. As was pointed out, it is extremely unfortunate that at the critical point, where the two faults intersect, there is a thick cloak of alluvium.

The above description removes, therefore, the difficulty which has been in the minds of those who have considered the problem of the relation of the thrust and normal faults skirting the Carboniferous rocks in the areas respectively to the south and north of Scone.

The implications raised by the recognition of the relationship discussed above for the faults are very important and far-reaching. These will be considered in a forthcoming paper which will deal with the tectonic history of the Carboniferous belt and some adjacent portions of the Permian areas.

Summarizing, it is seen that in late Palaeozoic time folding took place in the Muswellbrook-Scone district, as elsewhere in the Hunter Valley, and associated with this deformation were developed some strike faults, one of which was the Brushy Hill Fault. At a later period of movement the Hunter Overthrust developed, cutting across the earlier structures. Still later, further movement affected the area and the Wingen fault was formed. This was characterized by the production of a large disturbed zone, which began near Segenhoe and ultimately truncated the thrust, and depressed a portion of the edge of the thrust-flake.

The probable ages of the faults can be best considered when a greater area of the Carboniferous belt is under consideration, and accordingly this aspect will be deferred until the discussion in a later paper.

The writer wishes to record his thanks to Assistant-Professor Browne for helpful criticism of this paper.

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PLATE XXXVIII.

Geological map of the Carboniferous rocks in the Muswellbrook-Scone District.

NOTES ON AUSTRALIAN DIPTERA. No. xvii.

By J. R. Malloch.
(*Communicated by I. M. Mackerras.*)

(Twelve Text-figures.)

[Read 31st October, 1928.]

In this paper I offer some data upon a subfamily of Mycetophilidae, notes on the genus *Pachyneres* Greene belonging to Bombyliidae, a few notes on Asilidae, and notes on some already described species of Cyclorrhapha, most of the latter being in extension of matter already published in a previous part of this series of papers.

There are systematists who believe that a genus is a concept and that what binds it is not the genotype but the author's conception. What limits a genus is its genotype and, no matter how poorly the characters of the genotype may have been depicted by the original author of the genus, it stands to reason that all subsequently included species must conform to it in the essential generic characters, or else they are not congeneric.

The data presented in this and other papers of this series have been acquired during the past quarter of a century in working over material from all over the world, and almost invariably are not available in published form in any magazine either in Australia or elsewhere.

Frequently one finds that in a genus including many species from various faunal regions there are segregates which may readily be distinguished by structural characters and, when this is the case, it appears appropriate that these segregates should be given subgeneric or generic rank, so that the more closely related forms may the more readily be associated and in this manner form a ready basis for a generalization upon geographic distribution, a fad becoming more common than heretofore.

It was with this end in view that I have already dealt with some Brachycera in this series of papers and, in extension of this line of thought, I present below some notes upon a subfamily of Mycetophilidae. How many species there may be in some of the genera related to *Platyura* Meigen one can not even hazard a guess, but it is not improbable that there are some hundreds which only wide and intensive collecting will disclose. Unfortunately the insects are mostly fungivorous and of little or no economic importance so far as we at present know and, consequently, are of purely academic interest so that most collectors pay no attention to them. They do play, however, a part in our scheme of classification and as such must be considered on a parity with others which, because of their pernicious or beneficial functions, are more favoured in systematic literature for these reasons alone.

Suborder ORTHORRHAPHA.
Division NEMATOCERA.

Family Mycetophilidae.

Subfamily CEROPLATINAE.

In working over some North American material in the family Mycetophilidae to make comparisons with a few specimens received from several sources in Australia, I discovered some characters of group significance that appear to be worth recording for the benefit of Australian students of Diptera who may be interested in arriving at an accurate determination of the associations of Australian species with those from other faunal regions. To make matters as clear as possible I present herein a key to the genera of the subfamily Ceroplatinae which includes all the known genera and is similar in part to that by Johannsen published in 1909 (*Genera Insectorum*, Fasc. 20).

Not having access to several of the Australian genera, I am unable to make use of some of the new classificatory characters, such as the metathoracic hairs, included in the key and applied to the North American genera. If the publication of these data induces some student to investigate the Australian members of this subfamily further, I shall be more than satisfied with the result attained.

The subfamily Ceroplatinae belongs to the section of Mycetophilidae in which the medio-cubital crossvein of the wing is present, or in other words to that section in which there is a crossvein connecting the cubitus with media, usually beyond the furcation of the former. From the major portion of the subfamilies in this division it is readily distinguished by the obliteration of the radio-medial crossvein due to the fusion of a section of the basal portion of radius with media at the point where the crossvein should be. These features may be readily appreciated by a comparison of Text-figures 1 and 2 herein. The only subfamily in which the venation of the wings is similar to that of the Ceroplatinae in its essential features is Macrocerinae, but in the latter the antennae are very long and slender, usually not shorter, and often much longer, than the entire insect, while in the Ceroplatinae the antennae are never very slender, frequently conspicuously flattened, or even pectinate, and always much shorter than the entire insect.

Without access to a much larger amount of material than I have at present, I do not care to express a definite opinion as to the generic distinctness of the few Australian species I have before me, but am inclined to believe that when the species are carefully compared with those from the New World, some of them will be found to belong to different genera, for which new names will be required.

Key to the Genera.

1. Face and proboscis prolonged downward beak-like, the proboscis about as long as height of head, or longer than it 2
   Face and proboscis not prolonged downward, sometimes a short elevation on lower portion of face projecting forward or slightly curved downward 5
2. Vein R_{2+3} much longer than the distance from its base to the crossvein; apex of wing abruptly truncated ..... *Arctoneura* Hutton
   Vein R_{2+3} shorter than the distance from its base to the crossvein; apex of wing not abruptly truncated 3
3. Antennae with 2 + 15 segments, the apical one very small, papilla-like; subcostal crossvein present, the subcosta usually connecting with costa; prosternum, metanotum, and metapleura, bare ..... *Asindulum* Latreille
   Antennae with 12 or 14 flagellar segments; subcostal crossvein lacking 4
4. Subcosta short, connecting with costa; antennae with 2 + 12 segments ..... *Antriadophila* Skuse
   Subcosta free at apex; antennae 2 + 14 segmented ..... *Helladepichoria* Becker
5. Antennae pectinate, 2 + 12 segmented ..... *Platyroptilon* Westwood
   Antennae not pectinate 6

6. Antennae much flattened, strap-like; palpi porrect, short, dilated, not incurved .. 7
Antennae not conspicuously flattened; palpi slender apically, incurved, and moderately elongated 10
7. Tibiae and tarsi of mid and hind legs much thickened ..... *Heteropterna* Skuse
Tibiae and tarsi of mid and hind legs not thickened 8
8. Metapleura bare; mesopleura haired above; R_{2+3} connecting with R_1 ..... *Cerotelion* Rondani
Metapleura haired; R_{2+3} connecting with the costa 9
9. Upper portion of mesopleura haired ..... *Ceroplatus* Bosc., pt.
Upper portion of mesopleura bare ..... *Ceroplatus* Bosc., pt.
10. Media originating at base of wing, the basal section more or less evident 11
Media originating at the crossveins, its basal section lacking 12
11. Ocelli lacking, the vertex prominently elevated; R_{2+3} connecting with costa ..... *Hesperodes* Coquillett
Ocelli present, vertex not abnormally elevated; R_{2+3} connecting with R_1 ..... *Apemon* Johannsen
12. R_{2+3} short, less than half as long as R_{4+5} 13
R_{2+3} more than half as long as R_{4+5} 17
13. Antennae with 2 + 13 segments, almost cylindrical ..... *Pseudoplatyura* Skuse
Antennae with 2 + 14 segments, usually somewhat compresesd 14
14. Metapleura and upper portion of mesopleura with black hairs; all tibiae with one long apical ventral bristle; subcostal crossvein lacking ..... *Calliplatyura*, n. gen.
Metapleura bare; mid and hind tibiae each with one long and one slightly shorter apical ventral spur 15
15. Metanotum setulose; tibiae with 6 or more series of closely placed black spinules which form black lines from base to apex of each tibia; anal vein of wing distinct only at base, becoming evanescent outwardly, and never distinguishable to margin of wing ..... *Platyura* Meigen
Metanotum bare; anal vein of wing distinct to, or almost to, margin of wing 16
16. Some erect black hairs behind prothoracic spiracle ..... *Neoplatyura*, n. gen.
No erect black hairs behind prothoracic spiracle ..... *Xenoplatyura*, n. gen.
17. Petiole of media distinct ..... *Nervijuncta* Marshall
Petiole of media obliterated ..... *Casa* Hutton

Notes on the Genera.

Arctoneura Hutton. One New Zealand species known, *hudsoni* Marshall.

Asindulum Latreille. No Australian species known to me.

Antriadophila Skuse. Four known species, all Australian.

Helladepichoria Becker. One species; Canary Islands.

Platyroptilon Westwood. Type species from Brazil. The Ceylonese species *Platyura talaroceroides* Senior-White evidently belongs here also.

Heteropterna Skuse. Two Australian species.

Ceroplatus Bosc. There are two segregates of this genus known to me which are distinguished as indicated in the foregoing key. The group in which the mesopleura is haired on upper portion is represented in Australia, from whence I have seen one species (*mastersi* Skuse). The same group occurs in North America.

Cerotelion Rondani. One Australian species has been placed in this genus.

Hesperodes Coquillett. The genotype and only species is North American.

Apemon Johannsen. All the species of this genus so far recorded are from North America.

Platyura Meigen. There are about nine Australian species recorded for this genus, but whether any of them belong to it or not I am unable to say. I have divided the genus into four segregates in the foregoing key on the basis of characters that are apparently of generic value and possibly all of the Australian species will fall in one or other of these groups, though it is not improbable that

there may be present, in one or more of the species, structural characters which may indicate that they are entitled to separation from any of the included groups.

I have but one Australian species which would be referred to *Platyura* in the old sense, but it does not belong to the genus as herein restricted.

This limitation of the genus is based upon characters of the genotype as confirmed by Mr. J. E. Collin.

Calloplatyura, n. gen.

I have erected this genus for the reception of three species from the New World, the genotype being *Platyura elegans* Coquillett from North and Central America. The characters listed in the key form the basis of the genus.

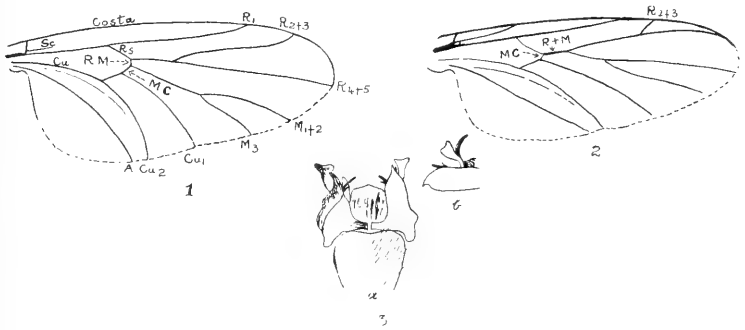
Neoplatyura, n. gen.

This genus is erected for the reception of those species in which the metanotum is bare. The distinction in the hairing of the mid and hind tibiae may be utilized as a subgeneric character. The genotype of *Neoplatyura* is *Platyura setiger* Johannsen, a North American species.

Genus Xenoplatyura nov.

I erect this genus for the reception of some Australian species which have the mesopleura bare behind the anterior spiracle, and the posterior branch of media and anterior branch of cubitus obsolete at apex. I have not enough material to go exhaustively into detail, but the group may contain a number of species of which I select *conformis* Skuse as genotype.

Before me there are two specimens of a species which I consider as probably *conformis*. If I am correct in this identification there are some stiff hairs on the anterior margin of frons between and above the antennal insertions which I have not seen in any other species hitherto placed in *Platyura*. I find, however, one South American species which is evidently undescribed, that has these hairs. In the latter the tibial hairs are serially arranged on the entire extent, while in the Australian species before me they are indiscriminately arranged, except at apices of tibiae.



Text-fig. 1.—*Ditomyia* sp., wing.
Text-fig. 2.—*Xenoplatyura* sp., wing.
Text-fig. 3.—*Xenoplatyura* sp. Ventral plate of male hypopygium. *a*, left side, from above, right side, from below; *b*, side view of apex.

The hypopygia present many characters for the differentiation of the species. Possibly the most valuable portion of these organs is the ventral plate and its

appendages, as shown in Text-figure 3. In addition to this plate there are two other portions of the male hypopygia, one internal, the other dorsal. I commend the study of these various parts of Platyurinae to Australian dipterists as a means towards the authentic identification of the species.

The two males which I assign to *conformis* are from Roma, Qld. (F. H. Taylor), and Cairns, Qld. (J. F. Illingworth).

Family Bibionidae.

This family has been separated from Scatopsidae by recent writers on the basis of structures of all stages. The adults are distinguished from those of Scatopsidae by the presence of the second basal cell of the wing.

The genera *Plecia* Wiedemann, *Bibio* Geoffroy, and *Dilophus* Meigen, are known to me from Australia. Skuse in 1888 dealt with the Australian species known to him (Proc. Linn. Soc. N.S.W., (2), 3, p. 1362) and later published a supplement (Id., (2) 5, p. 633), in which he recorded another species. I give below a key for the separation of the three genera mentioned above, with some notes on the genus *Plecia*.

Key to the Genera.

1. Third wing vein furcate, i.e., R_{2+3} present ..... *Plecia* Wiedemann
   Third wing vein not furcate 2
2. Fore tibia with a circle of spines at apex ..... *Dilophus* Meigen
   Fore tibia with a very strong spine-like process at apex ..... *Bibio* Geoffroy

Genus Plecia Wiedemann.

The species of this genus recorded by Skuse are *amplipennis* Skuse, which he afterwards synonymized with *fulvicollis* Fabricius, *erebea* Skuse, *dimidiata* Macquart, *ornaticornis* Skuse, and *melanaspis* Wiedemann. I have not seen *erebea*, but its entirely black thorax should be a good distinguishing character. Below I present a key to the species, with notes on those available.

Key to the Species.

1. R_{2+3} originating close to, or even at, the r-m crossvein, quite long, and extending almost parallel with R_{4+5}; thorax black, posterior half to two-thirds of mesonotum reddish fulvous; mesopleura and hypopleura quite distinctly haired; hypopygium as Text-figure 4 .... (Subgenus *Crapitula* Gimm.) .... *melanaspis* Wiedemann.
   R_{2+3} short, originating at much more than its length from the r-m crossvein and diverging from R_{4+5} at, or almost at, a right angle; mesopleura bare or almost so, hypopleura usually bare (Subgenus *Plecia* Wiedemann) 2
2. Thorax entirely reddish or ferruginous; eyes microscopically haired 3
   Thorax largely or entirely black; eyes bare 4
3. Second segment of scape of antenna reddish, the remainder black ..... *ornaticornis* Skuse
   Antennae entirely black ..... *amplipennis* Skuse
4. Thoracic dorsum ferruginous, black at anterior margin ..... *dimidiata* Macquart
   Thorax entirely black ..... *erebea* Skuse

Plecia (Crapitula) melanaspis Wiedemann.

This species belongs to the same group as *heteroptera* Say, a North American species, having the pleural hairing the same, and the male hypopygium with geniculated outer forceps. It has the vein R_{2+3} much longer, however, and, though this species has been given generic status distinct from the typical forms in which the face is quite distinctly protruded, the hypopleura bare, and the outer forceps of the male hypopygium not geniculated, I do not believe there is much to be gained by the procedure. The genus *Crapitula* Gimm., was erected for the

reception of *melanaspis*, as was also *Plecomyia* Brunetti. A character distinguishing it from *heteroptera* Say is the sessile media, the North American species having this vein pedunculate as in the remaining species occurring in Australia. Possibly subgeneric segregation would be the best course, as adopted herein, the basis of the segregation being the hairing of the hypopleura, and the form of the hypopygium. The genus *Rhinoplecia* Bellardi was erected for the reception of *rostrata* Bellardi (= *rostellata* Lw.), which has the face quite noticeably protruded, but this character is variable in the genus and can not be considered as of even subgeneric value. In any event the genotype of *Plecia* has the character rather evident so that it is synonymous with *Plecia*. The hind tibiae in the two species of this subgenus known to me are more conspicuously widened at apices, especially in the males, than they are in the typical forms. It is noteworthy that in *Crapitula* species the position of the medio-cubital crossvein is farther from the base of the anterior branch of cubitus than in the other group, the latter having the two forming a more or less angulate line, while in the former the basal section of the branch of cubitus is much longer than the crossvein and lies almost longitudinally, instead of almost erect or transversely.

I have seen this species from India and China, but have no Australian examples for comparison with them.

I have before me a female of *indica* Brunetti from Kashmir, India, which leads me to consider that it belongs to the subgenus *Crapitula* though, as in the North American species, the media is petiolate. From *melanaspis* this species is readily separated by the entirely red mesonotum.

PLECIA (PLECIA) AMPLIPENNIS Skuse.

This species was sunk as a synonym of *fulvicollis* Fabricius by Skuse in his second paper on *Plecia*, but I have grave doubts as to the accuracy of the determination of *fulvicollis*. Before me there are three specimens which may be referred to *amplipennis* as they have the antennae entirely black, and four specimens apparently referable to *ornaticornis*, having the second segment of the scape of antenna very noticeably reddish. Unfortunately neither of the two males I refer to *amplipennis* has the hypopygium present, so that I am unable to compare this organ with that of the species I accept as *ornaticornis* (Text-fig. 5).

I have five species of this group from the Orient, all of them, with the possible exception of *parva*, agreeing closely with the description of *fulvicollis*, so that it is a matter of arbitrary decision as to which is really that species. It is to be regretted that the type specimen of *fulvicollis* is no longer in existence, and an accurate check upon its identity is thus no longer possible. It may be permissible to accept as the true *fulvicollis* a species from Java in the material before me, and this course I am adopting. Whether this species is the same as *dorsalis* Walker and *subvarians* Walker, which species are at present accepted as synonyms of *fulvicollis*, I have no means of ascertaining at this time, but probably it is not, and either or both of these may be distinct from the species now available to me, as the latter appear to be rather local in their distribution. A check up on the Walker types will establish the identity of his species as he had both sexes in his type series. The type of *dorsalis* is from Singapore, that of *subvarians* from Sarawak; none of my material is from these localities. What *Penthetria thoracica* Guérin may have been can not be decided, but it is at present ranked as a synonym of *fulvicollis* and may be left as such.

Apart from the entirely black antennae there is no distinction between *amplipennis* and *ornaticornis* that I can make out. As these notes are intended

merely as guides to Australian students I leave the elucidation of the species on the basis of hypopygial characters, if these exist, to someone who has material for such a study.

Localities.—Vanikoro Is., Qld. (Dr. C. M. Deland), and Innisfail, Qld. (F. H. Taylor).

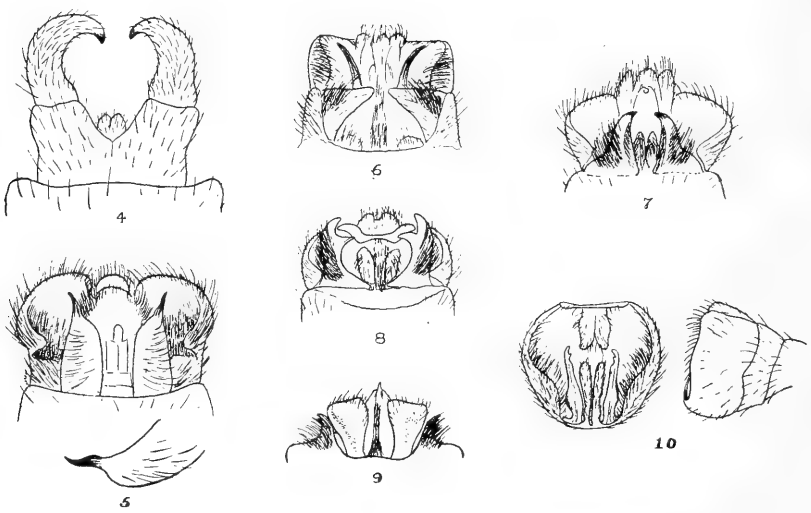
PLECIA (PLECIA) ORNATICORNIS Skuse.

This species I have before me in both sexes, one pair taken *in copula.* I figure the male hypopygium (Text-fig. 5), which is quite distinct from that of any of the Oriental species. Should there be but one species represented by this and the preceding species names, *ornaticornis* will fall as a synonym.

Localities.—Cairns, N. Qld. (J. F. Illingworth), Townsville, Qld. (F. H. Taylor).

PLECIA (PLECIA) FULVICOLLIS Fabricius.

I accept as this species one which occurs in Java, the larvae living at the roots of plants. One male was found amongst orchids from Java on a ship at San



Text-fig. 4.—*Plecia* (*Crapitula*) *melanaspis,* male hypopygium from above.
Text-fig. 5.—*Plecia* (*Plecia*) *ornaticornis,* male hypopygium and side view of inner forceps.
Text-fig. 6.—*Plecia* (*Plecia*) *fulvicollis,* male hypopygium.
Text-fig. 7.—*Plecia* (*Plecia*) *bakeri,* male hypopygium.
Text-fig. 8.—*Plecia* (*Plecia*) *philippinensis,* male hypopygium.
Text-fig. 9.—*Plecia* (*Plecia*) *confusa,* male hypopygium.
Text-fig. 10.—*Plecia* (*Plecia*) *parva,* male hypopygium, rear and side views.

Francisco, California, by O. E. Brenner, an inspector of the U.S. Federal Horticulture Board, but the species has not found its way into the United States as far as we know.

The head of the male is larger than in *ornaticornis,* and the ocelli are much less elevated, while the antennae are more slender, with the divisions between the

segments much more prominent, and the eighth flagellar segment is almost indistinguishable. The hypopygium as seen from below is as Text-figure 6.

Length, 7-8 mm.

Locality.—Buitenzorg, Java, at roots of *Cacao theobroma* (H. F. Deitz). The exact locality of the specimen found in San Francisco is unknown, but it came from Java. A female, apparently of this species and identified as such by Dr. de Meijere, is also from Java (Jacobson).

The following four species are described now to permit comparison with examples of related species occurring in Australia and Oceania, of which there are possibly several unknown to me and confused with *fulvicollis*.

PLECIA (PLECIA) BAKERI, n. sp.

Male and female.—Similar in coloration to *fulvicollis*, but the coxae are fulvous, not darkened, the mid and hind femora are yellowish at bases, and there is usually a dark central line on apex of the scutellum.

The eyes of the male are smaller than those of the male of *fulvicollis*, the ocelli are even more prominent than in the Australian species, and the antennae are 7-segmented in this sex, the apical papilla being indistinguishable with ordinary magnification. In the female the eighth flagellar segment is longer than the seventh, and while in all three species of this group discussed above, the distance from upper margin of eye to highest point of ocellar region seen from the side is less than half as great as the height of the eye, in *bakeri* it is fully as great as the eye. The male hypopygium as seen from below is as Text-figure 7.

Length, 6-7·5 mm.

Type, male, allotype, and two male paratypes, Baguio, Benquet, P.I.; one male and one female paratype, Limay, Batuan, P.I. The first series taken by Dr. C. F. Baker, in whose honour the species is named, the others taken by R. C. McGregor. In the United States National Museum Collection.

PLECIA (PLECIA) PHILIPPINENSIS, n. sp.

Male.—Similar in colour to *bakeri*, but shades a little deeper, with a dark central apical line on the scutellum.

The head structures are the same as in *bakeri*, but the hypopygium is as Text-figure 8.

Length, 7-7·5 mm.

Type, male, and one paratype, Tangcolan, Bukidnon, P.I.; one paratype, Lamboanga, P.I. (C. F. Baker). United States National Museum.

PLECIA (PLECIA) CONFUSA, n. sp.

Male and female.—More similar in general colour and structure to *fulvicollis*, the thorax bright orange or fulvous. The eyes of the male are very large, and minutely haired, the ocelli are small and very slightly elevated, and the antennal flagellum is 7-segmented. The head of the female seen from the side is similar to that of *ornaticornis*, and the flagellum is 8-segmented, exclusive of the minute apical papilla. The hypopygium of the male seen from below is as Text-figure 9, the forceps being omitted in the drawing.

Length, 8-8·5 mm.

Type, male, and allotype, Peradeniya, Ceylon, 25.8.13 (A. Rutherford). British Museum.

PLECIA (PLECIA) PARVA, n. sp.

Male and female.—A more uniformly coloured species than any of the others of the group, the thorax being ochreous, and not much paler than the brownish fuscous abdomen. The legs are hardly darker than the thorax and about the same colour as the dull ochreous pleura. Wings pale brown. Halteres with the knobs dark brown.

Eyes large, and microscopically haired, in male, ocelli large and very prominently elevated, antennal flagellum with but six segments, exclusive of the almost indistinguishable apical papilla; frons of female broader than long, bare, height of frons above eye in profile more than half as great as that of eye, antennal flagellum stout and uniformly thick, the segments closely adherent, apparently eight in number. Legs stouter than usual. Hypopygium large and stout, with an apical opening as shown in Text-fig. 10. Venation similar to that of *ruficollis*.

Length, 4-5 mm.

Type, male, and allotype, Los Banos, P.I.; one male paratype, Kolumbugan, Mindanao, P.I. (C. F. Baker). United States National Museum.

None of the Australian species belonging to the other section is available to me at this time.

I find that the wing venation in any species is quite variable, and no mention of any venational features is made in the descriptions of the species for this reason. The internal portions of the male hypopygium appear to be characteristic in the different species, but I had insufficient material to permit of an intensive study of these organs, merely figuring them as seen in the dry specimens, though I did take the pains to denude them so that the contours could be the better distinguished. This denuding may be easily done by using a fine camel-hair brush, bringing it lightly to bear on the hypopygium and drawing it in the opposite direction from which the hairs are directed.

Division BRACHYCERA.

Family **Bombyliidae.**

Genus PACHYNERES Greene.

When I placed my species *australis* in this genus, I did not make an exhaustive examination of the literature of the family Bombyliidae, but after Mr. G. H. Hardy suggested referring the genus to the family Bibionidae without having seen the specimens I took the trouble to discover whether any other data upon its affinities were available. I now am able to report that the genus *Pachyneres* is a synonym of *Glabellula* Bezzi, and that for quite a number of years it has been firmly established as a Bombyliid, with the accord of Bezzi, Verrall, Wahlgren, and other European authors. The synonymy of the genus is as follows, the Zetterstedt allocations being to the family Cyrtidae.

GLABELLULA Bezzi.

Zeitschr. f. Hymen. u. Dipt., vol. 2, 1902, p. 191, n.n. for *Glabella* Loew.

Platygaster Zetterstedt, *Ins. Lapp.*, Diptera, 1838, p. 574, preocc. by *Platygaster* Latreille in Hymenoptera, 1809, and *Platygaster* Schill., in Hemiptera, 1829.

Sphaerogaster Zetterstedt, *Dipt. Scand.*, vol. 1, 1842, pp. 22 and 232, n.n. for *Platygaster* Zetterstedt. Preoccupied by *Sphaerogaster* Dejean, in Coleoptera, 1821.

Glabella Loew, *Beschr. Europ. Diptera*, vol. 3, 1873, p. 210, preoccupied by *Glabella* Swains., in Mollusca, 1840.

Pachyneres Greene, *Proc. Ent. Soc. Washington*, vol. 26, 1924, p. 62.

In neither of the two specimens of *australis* which I had was there any indication of a short process at apex of the third antennal segment, such as is conspicuous in the two species referred to *Glabellula* in Europe. I have examined specimens which appear to be referable to these two species in the collection of Dr. A. L. Melander, and the apical process is very readily distinguished. I do not believe that this process had been broken off in the Australian examples and, even so, without a process, I consider it unnecessary to erect a new genus for the reception of the species without other differentiating characters of more significance.

I have no doubt that with careful collecting this species will be found to be more common than is generally supposed. It very closely resembles *femorata* Loew in colour and general appearance.

It interests me to note that in a paper just received Mr. G. H. Hardy accepts the species discussed above as a Bombyliid, having seen the type and another specimen. No mention is made by him of the above synonymy so this note may stand as written.

Family **Asilidae.**

Subfamily Dasypogoninae.

Genus Stenopogon Loew.

The genotype of *Stenopogon* is *sabaudus* Fabricius, a European species. To determine the relations of the Australian species before me which have been referred to *Stenopogon*, I made a critical study of the American forms and the genotype. The notes presented below are the results of this study.

Loew erected the genus *Scleropogon* in 1866 for the reception of *picticornis* Loew, a Californian species, distinguishing the genus from *Stenopogon* by the narrower face and frons, the shorter third antennal segment, with its longer style, the closed first, and the widened third, posterior cell of wing. Back, in 1909, discarded the genus, as did Coquillett before him, finding that the distinguishing characters were not stable; he stated, however, that he was confident subgeneric divisions could be made out when carefully collected material was brought together.

My study of the genus indicates that there are at least four segregates which may be accepted as subgenera, and possibly as genera, when all the evidence is in. I append a key to these groups below, all segregates will run down to *Stenopogon* in Ricardo's key to the genera of Asilidae.

Key to the Subgenera.

1. Metapleura bare; all posterior cells of wings open; mesopleura bare 2
   Metapleura haired or bristled in front of halteres and above spiracle 3
2. Both sections of first abdominal sternite haired on entire extent ..... *Stenopogon*, pt. (N.Amer.)
   Anterior section of first abdominal sternite haired on entire extent, posterior section haired in centre of anterior margin ..... *Stenopogon*, pt. (Europe)
3. Posterior section of first abdominal sternite haired in middle of anterior margin; first posterior cell of wing normally closed and petiolate ..... *Scleropogon*, pt.
   Posterior section of first abdominal sternite bare 4
4. Mesopleura bare ..... *Scleropogon*, pt.
   Mesopleura haired above and behind ..... *Neoscleropogon*, n. subgen.

Subgenus Neoscleropogon nov.

This subgenus has the head a little wider than high, the facial swelling not extending much above middle of face, the upper half of face densely haired, and

the pleural hairs long. There is a variously formed dorsal process which projects backward over the hypopygium in the males, whereas in the other groups there is no such central process.

Subgenotype, *Dasypogon elongatus* Macquart.

There are at least two other Australian species. In all species known to me the tarsi are shorter and wider than is usual in *Stenopogon*. Possibly the group is entitled to full generic status, thus removing *Stenopogon* from the list of Australian genera.

Genus Thereutria Loew.

This genus does not belong to Laphriinae, having the prosternum disconnected from the propleura, a character pointed out in one of my preceding papers as important in distinguishing members of Dasypogoninae from those of Laphriinae. I note that in a paper by Hardy received after my manuscript of that paper was sent to press this genus was removed along with *Metalaphria* Ricardo to Dasypogoninae and placed in the tribe Saropogonini. This tribe contains, in Hardy's sense, species in which the females possess genital spines, but the division is not a very sharp one, as is indicated by his key to the tribes, and it has the disadvantage of being based upon a character of one sex alone.

Thereutria undoubtedly belongs to Dasypogoninae, as does also *Metalaphria*, and the two genera are very closely related, possibly not entitled to separate generic rank. I have attempted to find characters other than those originally cited for their distinction, and have discovered at least one additional feature. This is the presence of sternopleural hairs in *Thereutria* and their absence in *Metalaphria*. Whether this character will hold throughout for the species involved in accord with the original definitions I am unable to say, but they hold in the material now before me.

It appears worthy of note that there is evidently considerable difference in the coloration of the legs in the sexes of the same species in *Thereutria*. I make this statement because in a pair mounted *in copula* now in my possession, the male has the legs entirely black with the exception of the basal half of the hind metatarsus, which is whitish, while the female has the femora and tibiae testaceous yellow with the tips of former, and apices of tibiae more broadly, black; the base of hind metatarsus is whitish-yellow as in male. Two other male examples have the mid and hind tibiae whitish above (dorsally) except at apices, and the hind metatarsus coloured as in the other specimen. I accept these two last as normally coloured males of *pulchra* Schiner, and the first mentioned example as a dark legged variety. Miss Ricardo's description of *amaracus* Walker, with its synonyms, appears to suggest that the female above mentioned is included amongst the forms, and that careful field work is required to establish the related sexes, if there are several species and not only one.

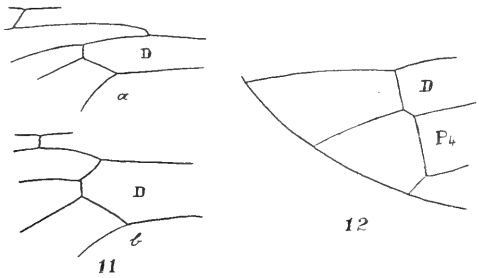
Genus Metalaphria Ricardo.

In addition to the character mentioned above for the distinction of this genus from *Thereutria*, possibly the hairing of the frons will be of value. In *Metalaphria*, or at least in the species before me, there are a few hairs on each side on the frons a short distance proximad of the anterior ocellus, situated on slightly raised areas, and no hairs on extreme lateral margins of frons close to eyes, while in *Thereutria* there are no hairs where they are present in *Metalaphria* and there is a series of hairs along each lateral margin of frons on its entire length close to the eyes.

Subfamily LAPHRIINAE.

Genus LAPHRIA Meigen.

This genus as at present accepted is, as I pointed out in my previous paper on the family, composite. One of the most striking digressions from type is found in *notabilis* Macquart, a species from the Aru Islands. In this species the metanotum has a group of bristles and hairs on each side, the hind coxae are produced in the form of thin plates at apices above, the hind trochanters are longer than their coxae, gradually thickened from bases to apices, and furnished with a group of bristles on ventral side at tips, and the mesopleura has an angular projection on hind margin above the series of bristles. I have seen only the female, so can not state whether these characters hold good in both sexes. In venation this species agrees with typical species of *Laphria*, having the apex of second basal cell as in Text-figure 11. The distinction between typical Laphriinae and typical Dasypogoninae, insofar as this character is concerned is shown in the



Text-fig. 11.—*Thereutria pulchra* (*a*), and *Laphria* species (*b*), apex of discal cell of wings.

Text-fig. 12.—*Laphria scapularis*, apices of discal and fourth posterior cells of wing.

figure mentioned. In another species, identified by Coquillett as *Atomosia scapularis* Wiedemann, from the same island, the veins closing discal and fourth posterior cells are in an almost continuous line (Text-fig. 12), but the species is an undoubted *Laphria* belonging to the group in which the metanotum is bare on the lateral regions.

Subfamily ASILINAE.

Genus OMMATIUS Wiedemann.

Recently Mr. G. H. Hardy has proposed to give tribal rank to this genus and one or two others which agree with it in having the arista with long hairs on one side.

I have several Australian species of the genus *Ommatius* before me and desire to draw the attention of students to some of the more important characters of the groups represented. Miss Ricardo's paper serves to distinguish *Ommatius* and two closely related genera from others, on the basis of the pectinate arista. I have before me only species that would fall within the genus *Ommatius* in the sense of that paper, but *chinensis* Fabricius, because of the elongate third antennal segment, appears to give ground for the belief that the careful student might be tempted to consider the species belongs to the genus *Allocotosia*, though the segment is only equal to the combined lengths of first and second. Curran, in a recent paper on the African species (*Bull. Amer. Mus. Nat. Hist.*, vol. 57, 1928,

art. 6, p. 334), notes that *Emphysomera* Schiner is scarcely tenable, as there is every gradation in the shape of the femora from greatly swollen to rather slender. Miss Ricardo cites as the distinguishing feature of *Emphysomera* the flat face, and makes no mention of the structure of the femora. Curran makes no mention of *Allocotosia*, but disregards some other generic segregations.

In making a comparative study of the few Australian and American species that I have access to, I was struck by the fact that *Ommatius* has several features that serve to isolate it, in addition to the pectinate arista. One of the most striking of these structural characters consists of the chitinized plate above the hind coxae which extends entirely across the hind margin of the thorax and is furnished with fine hairs similar to those present on the abdominal sternites. Besides this there is, as usual in Asilinae, a divided basal abdominal sternite, the apical portion of which is bare and the basal portion haired.

I can see no reason to distinguish even subgenerically the Australian and North American forms, but in the case of *chinensis* there are characters that appear to justify its segregation. These consist of the presence of a group of fine hairs on each side of the extreme base of first abdominal tergite and lying close against the metanotum, and a similar group close to scutellum on the line separating the postalar declivity and the metanotum. In addition to these features, the hypopygium of the male appears rather radically different from those of the other group, and the discal cell of wing is elongated and narrow at apex. In both segregates the hind coxae are haired above the bases of their femora on posterior sides. I rather suspect that *chinensis* may be referable to *Allocotosia*, but I have not access to the genotype of the latter for comparison.

It appears pertinent to note that, in one Javanese species and another from Africa which I have before me, there is a long bristle on the middle of the pteropleura in addition to the normal soft hairs, which bristle is lacking in all other species now known to me.

Genus Promachus Loew.

This genus is readily separated from the great bulk of genera in the subfamily by the venation of the wings. Every sclerite of the pleura, except the small subtriangular one at upper posterior angle of mesopleura, is partly haired, the metanotum is bare on the lateral swollen areas, the mesosternum and metasternum are haired, and there are some hairs on the membranous or semimembranous base of abdomen immediately above the bases of hind coxae; similar but more evident hairs are present in *Ommatius*, but the portion of abdomen on which they are situated in the latter is chitinized and not membranous.

Two striking characters of the genus are the presence of hairs and bristles on the small sclerite directly below the anterior extremity of the base of wing, and the fact that the margin of scutellum has the strongest bristles above the usual depressed line and well removed from the lower edge, while there is a weaker series below these and almost on the edge.

I have before me only *doddi* Ricardo, from Cairns, N. Queensland, and in it the characters agree with those of the North American species with which I have compared it.

Genus Asilus Linné.

This genus has been subjected to much arbitrary subdivision, and unfortunately most of the segregates, the more outstanding of which are usually given subgeneric rank, are based upon characters of one sex, most frequently the female.

I have taken the opportunity already in this series of papers to decry the use of characters of one sex for the segregation of groups of species no matter whether such segregates be considered genera, subgenera, or merely un-named groups.

I have tried to assign the North American species of *Asilus* to subgenera, with rather unsatisfactory results. I do find, however, that there are several characters apparently of value for the grouping of species, some of which have not heretofore been made use of for segregations in this genus. In the North American material I find that there are three groups divisible as follows:

1. Metanotum bare; tarsi normal ..... Group I
   Metanotum with bristles or hairs on each side 2
2. Tarsi normal ..... Group II
   All tarsi with an elongate oval depression in base of fifth segment on its ventral surface, apex of fourth with a rounded excavation connecting with same ..... Group III

In Group I there are two North American species, one with, the other without, spines on the genitalia in the female. In Group II all of the species have the genitalia without spines; and in Group III one species has the genitalia of the female spinose, and eighteen have no genital spines. It is not appropriate to dilate herein upon the relationships of the American species, but it may be worth while to examine the Australian material in the light of these data.

Amongst the comparatively few species of *Asilus* from Australia that I have, I find several that have the metanotum bare, and others that have a group of hairs on each side of metanotum. Both groups have the tarsi normal and thus they would appear to fall within Groups I and II as defined above. There are, however, so many other characters in which they differ from the North American species, such as the shape and bristling of the face, that it would be unwise to place them in the same groups either named or un-named. I have seen no Australian species with the peculiar fifth tarsal segment described in the above key, but such may exist.

Suborder CYCLORRHAPHA.

Family **Sepsidae.**

In a previous paper in this series I drew attention to the fact that Dr. O. Duda's first part of his monograph on the family Sepsidae bears the statement that it appeared in December, 1925, but suggested that verification was necessary as many continental European magazines do not appear on the dates which they bear. I am now able to state on information given me by Dr. H. Zerny, custodian of Diptera in the Austrian National Museum, that the first part of that paper appeared on January 16, 1926, and the second part on December 10, 1926. The second part bears the notation that it appeared in November, 1926. My genus *Australosepsis* therefore has priority over *Saltelliseps* Duda.

Genus PODANEMA Malloch.

I have recently received from Dr. Duda the second part of his monograph and find that his description of *Toxopoda* Macquart agrees with that of *Podanema*. My genus thus falls as a synonym, but the Australian species is distinct from the only one he places therein, *nitida* Macquart (*viduata* Thomson).

Family **Ortalidae.**

Genus POGONORTALIS Hendel.

This genus is distinguished from any in the subfamily Platystominae by the very large mouth, which occupies almost two-thirds of the head width when seen

from below, leaving only a narrow cheek between it and lower margin of eye which is not half as wide as third antennal segment. Other distinguishing features are the presence of a number of long bristly hairs on the hind part of lower margin of cheek in the male and of one rather strong bristle about its middle in female; the mesopleura has a strong upper hind marginal bristle; scutellum bare except for the four bristles; first and third veins setulose above to apices, bases of second and third setulose below; anal cell shortest on its lower side, not pointed at lower apical angle; distance between apices of first and second veins about half as great as that between second and third.

POGONORTALIS BARBIFERA Hendel.

This is the only species known from Australia. It is distinguished from the other two species placed in the genus by the dark brown wing markings which consist of a central vitta extending from base to inner crossvein and filling the entire cell, a costal mark filling the cell between apices of auxiliary and first veins, a narrow fascia extending from apex of vein over disc of wing as far as third vein, a spot at apex beginning on costa above apex of third vein and extending below that vein, but less distinctly, to apex of fourth; and a cloud on vein closing posterior basal cell. Body fuscous to black. Legs brownish-yellow, sometimes with the femora and tibiae partly darker.

Arista bare; each orbit with two bristles; ocellars very weak; all verticals strong; postverticals minute. Only the prescutellar dorsocentrals and acrostichals distinct.

Length, 4 mm.

Localities.—Burpengary, S. Qld. (Dr. T. L. Bancroft); Sydney, N.S.W. (H. J. Carter). Hendel recorded the species from these same localities.

Genus EUPROSOPIA Macquart.

EUPROSOPIA TENUICORNIS Macquart.

I have seen a pair of this species in the United States National Museum from the Baker collection, taken on Stradbroke Island, 5.12.13 (H. Hacker). These were identified as *australis* Walker, but they do not agree with the description of that species. The male has two long slender flattened bristles at apex of basal segment of fore tarsus on its anterior side, which are curved downward and outward. The apices of first and second visible tergites in both sexes, and the whole of third and fourth tergites in male have pale yellow scale-like hairs.

EUPROSOPIA MACULIPENNIS Macquart.

Two specimens from Brisbane (H. Hacker), from the same collection, have a faint greyish-brown fascia over the region of the outer crossvein of wing which is not shown in Hendel's figure of the wing of this species. Abdomen as in *tenuicornis*, but with a few pale scales on third visible tergite in female.

Family **Calliphoridae.**

Subfamily RHINIINAE.

Genus RHINIA Robineau-Desvoidy.

RHINIA XANTHOGASTER Wiedemann.

In the material of this family submitted to me at my request by Dr. H. Zerny, of the Austrian National Museum, there are three specimens of this species from the old collection of that museum, two of which bear the label "New Holland",

and the other with the same label, but with the addition of a question mark (?) after the locality. I have yet to see a specimen which is unquestionably from Australia, though I do not doubt that it occurs there. The specimens referred to above are identical in all respects with Javanese specimens from the Vienna Museum and in my own collection.

It appears to be pertinent to note that the specimen sent me from Vienna, which bears the type label and the locality Java, is not *xanthogaster*, but a species of the genus *Idiella*, possibly *mandarina* Wiedemann. It is evidently mislabelled as it does not agree with Wiedemann's description, the tibiae and bases of tarsi being yellow, and the apex of the abdomen blackened.

Subfamily Calliphorinae.

Genus Calliphora Robineau-Desvoidy.

Calliphora ochracea Schiner.

Seven females from the type series in the Vienna Museum conform to my interpretation of this species already published in this series of papers in having the thorax obscured by ochreous dusting.

These specimens bear the Novara label and the locality Sydney.

Calliphora stygia Fabricius.

A series of 31 examples of this species, mostly from the Novara collection, and named by Schiner and Brauer and Bergenstamm, was sent for examination by Dr. Zerny. There is not a single specimen of *hilli* Patton in the series.

Most of the specimens are from Sydney, but some are from Swan River.

Calliphora tibialis Macquart.

Two males of this species were misidentified as *villosa* by Schiner. They are from the old collection of the Vienna Museum and are labelled simply New Holland.

Calliphora augur Linné.

A dozen specimens of this species are in the Vienna Museum. Most of them were named *oceania* by Brauer and Bergenstamm; a few from the old Winthem collection are from Swan River, most of the others are from the Novara collection and labelled Sydney.

Calliphora centralis Malloch.

One male of this species was confused with the preceding one and labelled *oceania* by Brauer and Bergenstamm also. It is evidently one of the specimens from Schiner's material as it was collected at Rockhampton by Thorey in 1868.

Calliphora quadrimaculata Swederus.

A dozen specimens of this species named *dasyophthalma* Macquart, mostly from the Novara collection, all from New Zealand, are in the Vienna Museum material. I have seen no Australian specimens of this species.

Calliphora (Xenocalliphora) hortona Walker.

A dozen specimens of this species from the Novara collection, all from Auckland, N.Z., bear the identification *aureopunctata* Macquart by Brauer and Bergenstamm.

Family **Tachinidae.**

I am presenting below some additional data on Ameniini and Rutiliini with notes on the genus *Microtropeza* Macquart. This information was derived from an examination of material submitted by Dr. H. Zerny, some of which consisted of types of Brauer and Bergenstamm species, and of species identified by them, as well as types of some of Schiner's species.

I have now seen the genotypes of all the genera included in Engel's paper, except that of *Paramphibolia* Brauer and Bergenstamm, which genus is unknown to me.

Tribe **Ameniini.**

Genus AMENIA Robineau-Desvoidy.

AMENIA PARVA Schiner.

I have before me a male and female of this species, apparently the types, and they confirm my previous identification of the species. They are labelled Sydney, and bear the printed label Novara R. The smaller of the two specimens is almost 7 mm. in length. Both specimens are in perfect condition.

Genus PARAMENIA Brauer and Bergenstamm.

I now have before me the type specimen of *semiauriceps* and can confirm my previous statement that it is the same as *macularis* Walker. The locality of the type is Port Denison (Thorey, 1868).

I have also examined two males in the Baker collection, now in the United States National Museum, which differ from the females in having the frons linear and the frontal orbits and upper portion of parafacials yellow, and not white, dusted, hardly paler than the lower portions of parafacials.

These last specimens are from Brisbane.

Tribe **Microtropezini.**

Genus MICROTROPEZA Macquart.

This genus does not belong to the foregoing tribe, though the triangularly exposed abdominal sternites with their strongly spinose apices are the same as in that tribe. It differs from all three genera placed by me in Ameniini in having no hairs just below the lower calypter, many erect hairs on the supra-spiracular convexity, the postscutellum evenly rounded and convex and not with a broad shallow central apical concavity or emargination. The prosternal plate, postalar declivity, and suprasquamal ridge are bare, and the centre of propleura and apices of hind coxae above the bases of femora are haired. The pleural knob is not elevated as much as the portion above it, the arista is bare, and the parafacials are entirely haired.

MICROTROPEZA SINUATA Donovan.

Head yellow, and yellow dusted, interfrontalia and antennae orange, third segment of latter sometimes fuscous. Thorax fulvous testaceous, sternopleura and dorsum of thorax largely infuscated, the latter greyish dusted, with a slight metallic tinge and four narrow black vittae. Abdomen varying from castaneous to black, shining, with anterior margins of tergites 2 to 4 grey dusted, more broadly on 4, and on 3 and 4 with a central extension of the grey dust giving the tergite the appearance of having two large black apical spots; the black portions sometimes tinged with metallic blue. Legs yellow, tarsi fuscous. Wings greyish hyaline, yellow at bases. Calyptrae yellow.

Frons at vertex about one-fourth of the head width in male, about one-third of the head width in female; each orbit with some strong forwardly directed bristles in female, none in male; third antennal segment about 1·5 times as long as second; palpi slightly spatulate at apices. Thorax with 3+4 pairs of dorsocentrals, the presutural acrostichals well developed, and the sternopleurals 2 or 3+1. Bristles on apical margin of third abdominal tergite almost continuous, those on apex of fourth in two lateral groups. Fore tibia with an almost complete series of anterodorsal bristles in female, these less distinct apically in male.

Length, 14-15 mm.

I have before me a male labelled "New Holland", and a female labelled Rockhampton, the latter from the Schiner collection, both from the Vienna Museum.

The supraspiracular hairs on metanotum distinguish the genus from its allies.

Tribe **Rutiliini.**

In neither of my two previous papers on this tribe did I present a key for the identification of the genera. This was due to the fact that I lacked several of the genera usually referred here, but now having had an opportunity to examine all of those included by Engel in his paper, except one genus, I present a key for their identification which I hope may be of service to Australian students of the family.

It is not a simple matter to define the tribe and at present I can only offer as distinguishing characters the presence of a pronounced vertical central carina on the face, hairs on centre of propleura, and of only a few short bristles on base of anterodorsal surface of fore tibia. Locally the species may generally be recognized by their large size and robust build, coupled with their bright colours and strongly bristled abdomen, but there are some large robust genera such as *Euchaetogyne* Townsend which may readily be confused with them. A thorough revision of the group based upon large series of specimens of each species is essential to a thorough understanding of the relationships and this can be best accomplished in Australia.

Key to the Genera.

1. Suprasquamal ridge haired 2
   Suprasquamal ridge bare 5
2. Second and third visible abdominal tergites each with a pair of short stout bristles in centre near anterior margin; parafacials bare below apex of second antennal segment ..... *Amphibolia* Macquart
   Second and third visible abdominal tergites without bristles, except sometimes at apices 3
3. Facial carina narrowly rounded above, lower end almost sharp below; parafacials with rather long black setulose hairs to below lowest level of eye ..... *Chrysopasta* Brauer and Bergenstamm
   Facial carina broadly rounded, sometimes with a central sulcus above, flat below; parafacials with or without hairs, if these are present they are usually fine and rather short ..... (*Rutilia* Robineau-Desvoidy, *sens. lat.*) .. 4
4. Arista pubescent or bare ..... *Rutilia* Robineau-Desvoidy, *s.s.*
   Arista short haired, the longest hairs about half as long as width of third antennal segment ..... *Senostoma* Macquart
5. Postalar declivity bare; palpi minute ..... *Prodiaphania* Townsend
   Postalar declivity haired in centre ..... (*Formosia* Guérin, *s.l.*), 6
6. Arista long haired ..... *Formosia* Guérin, *s.s.*
   Arista pubescent or bare ..... *Euamphibolia* Townsend

Genus CHRYSOPASTA Brauer and Bergenstamm.

This genus is very similar to *Rutilia*, but the facial carina is much narrower, being only narrowly rounded above and not so high and almost sharp on lower portion. Although the hairing of the parafacials in *Rutilia* is very variable, not one of the species has the hairs as long and strong as does this monobasic genus. Although Engel, in his paper on Rutiliinae, stated that this genus has the abdominal sternites the same as in Ameniini, this is erroneous. The specimens before me, and presumably he had the same pair for examination, show some differences, as the male has the abdomen unduly extended, exhibiting the sternites on its entire length, while the female has the sternites, except the apical one, concealed by the overlapping tergites. Even a cursory examination of the male discloses the fact that the sternites are quite different from those of the other group, the latter being more broadly exposed at apices than at bases, sometimes almost triangular in exposed area, while in *Chrysopasta* they are narrowed at apices; the apical bristles are also much weaker than in Ameniini.

CHRYSOPASTA VERSICOLOR Brauer and Bergenstamm.

This species, the only one of the genus so far recorded, is metallic green or blue-green, with distinct whitish dusting on dorsum of thorax and abdomen, and on the mesonotum four quite conspicuous black vittae which are broken at suture and cease about midway between suture and hind margin. Head testaceous yellow, frontal orbits, parafacials, and cheeks, with variable checkerings of pale dust; third antennal segment fuscous except at base; arista pubescent, fuscous; palpi yellow; parafacial hairs strong, long, and black; occipital hairs yellow; upper occiput green. Dorsocentrals 3+4; all thoracic hairs black; scutellum yellowish in ground colour, suffused with metallic green. Basal tergite black, the others with black apices and a black central line, the green portions whitish dusted. Legs black; hind tibia with a few long bristles on anteroventral, anterodorsal, and posterodorsal surfaces, the male with a fringe of anterodorsal bristles, one or two of which are longer than the others, the anteroventral and posterodorsal surfaces as in female. Wings hyaline, veins yellowish basally.

Length, 14-15 mm.

Redescribed from type male and allotype, from Swan River, W. Australia, in the Winthem collection of the Vienna Museum.

Genus RUTILIA Robineau-Desvoidy.

Subgenus SENOSTOMA Macquart.

I have before me one specimen in rather poor condition which is referable to this subgenus. I do not consider *Senostoma* as entitled to full generic rank as, apart from the smaller size and less strongly bristled abdomen of the species, only the presence of distinct hairs on the arista serves to separate it from typical species of the genus *Rutilia*.

SENOSTOMA RUFICORNIS Macquart.

Head yellow, with paler dusting on all parts except the interfrontalia; antennae and palpi yellow; parafacials bare; facial carina broad and almost flat; longest hairs on arista about half as long as width of third antennal segment. Thorax fulvous yellow, mesonotum metallic green, with whitish dust, and rather distinctly quadrivittate; humeri, pleura, and scutellum, fulvous yellow, with variable green shading. Abdomen metallic green, becoming fulvous below, dorsum with a

blackish central line and slight white dust. Legs fulvous yellow, tarsi darker. Wings greyish hyaline, without a blackish basal mark. Calyptrae white.

Thoracic dorsal bristles distinct, dorsocentrals 3 + 4, acrostichals well developed; scutellum not as much flattened as in most species of *Rutilia*, with 6 or 8 marginal and 4 or 6 submarginal bristles. Abdomen with rather long bristles at apex of third and on middle of fourth visible tergite. Hind tibia with one or two outstanding bristles in the series on anterodorsal surface, about four long posterodorsal, and two shorter anteroventral bristles.

Length, 12 mm.

One specimen labelled "New Holland", from the Austrian National Museum.

The types of *flavipes* B. and B. ought to be in the Austrian National Museum, but they were not sent to me with the other material herein reported upon, and the specimen from which the above description was written was without a species name. Previous records include Cairns, Herberton, Katoomba, and West Australia.

I have not yet had time to deal with the genus *Formosia*, but hope to do so at an early date.

THE PHYSIOGRAPHY OF THE WOLLONDILLY RIVER BASIN.

By Frank A. Craft, B.Sc., Science Research Scholar,
University of Sydney.

(Plate xxxix, and twelve Text-figures.)

[Read 28th November, 1928.]

Introduction: Literature; General Considerations.
Geology of the Area: Resistance to Erosion.
Topographic Divisions: 1, Blue Plateau (South); 2, Jenolan Plateau; 3, Western Wollondilly—Abercrombie Block; 4, Shoalhaven Plateau; 5, Lake George Complex; 6, Nepean Ramp.
Features of Special Interest: 1, Mt. Werong; 2, Burragorang Valley; 3, The Tonalli Valley; 4, The Cookbundoon Basin; 5, Upper Wollondilly Valley; 6, Bredalbane Valley; 7, Lake George Area; (*a*) Lake Bathurst; 8, Wingecarribee—Nattai.
Physiographic Types: 1, The Peneplain; 2, Valleys of the Plateau; 3, Monadnocks; 4, Basalt as a Physiographic Problem.
Warps and Faults of the Area: *a*, Kowmung Warp—Nepean Ramp; *b*, South Jenolan Warp; *c*, The Kanangra—Cookbundoon Fault; *d*, The Norwood Warp; *e*, The Cullarin Fault; *f*, Mulwaree Fault; *g*, Sassafras Fault; *h*, General Review of the Faulting.
Streams of the Area.

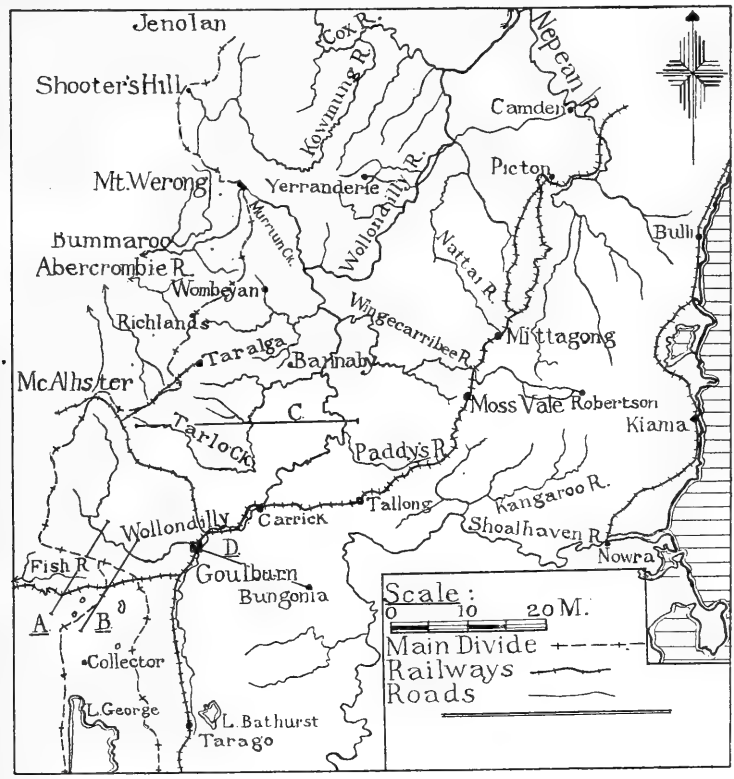
The research embodied in this paper was undertaken by the author during 1927, under the general supervision of Professor Griffith Taylor, as a Science Research Scholar in Sydney University. It is a continuation of similar work carried out in 1926 in the country immediately to the north in the Cox River Basin. The author is much indebted to Professor Taylor for his continual help and encouragement, and this paper owes not a little to him. Grateful acknowledgment is also made of the services of Mr. Bowler, of the Lands Department, Sydney, who placed maps and certain topographic information which that Department possessed at his disposal. This work should be read as a continuation of the author's paper on the "Physiography of the Cox River Basin" (Proc. Linn. Soc. N.S.W., liii, Part 3, 1928, 207).

Literature.—With the exception of areas around Tallong, Mittagong, and Lakes George and Bathurst, no considerable physiographic work had been carried out in this area. A few leading references to works bearing on the area and the problems met therein are given at the end of the paper.

General Considerations.—The basin of the Wollondilly River comprises an area of approximately 2,000 square miles, and this paper deals to some extent with an additional area to the south, in and adjacent to the Shoalhaven Basin. The whole area is the southern slope of the Central Tableland "Massif", whilst the central and southern portions also form Taylor's "Lake George Geocol", which has an elevation of 2,300 feet and lies between the Central and Southern Tablelands, which have respective altitudes of 4,400 and 6,500 feet.

The eastern plateau blocks of Southern Queensland and New South Wales consist of three great masses, New England, the Blue Plateau, and the Canberra-

Kosciusko Highlands, separated from one another by the Cassilis and Lake George "Geocols" in the north and south respectively. Presumably there have been two great groups of epeirogenic uplifts during the Kosciusko epoch in this region, which produced the New England and Kosciusko Plateaus respectively. The crossing and mutual reinforcement of these uplifts produced the Blue Plateau. In localities where the forces of uplift died out before meeting, as in the Sydney



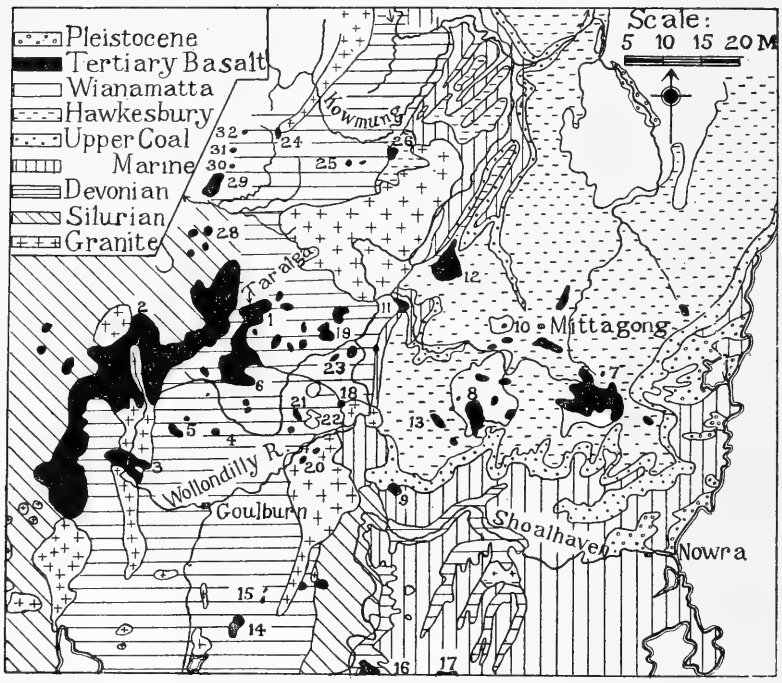
Text-fig. 1.—Locality Map. The Wollondilly Basin and surrounding areas are shown. Heavy lines refer to sections in Text-fig. 12.

Basin, the low-lying, slightly-dissected surface of the old Late Tertiary peneplain is still met with. In the north of the Wollondilly area, then, the typical features of the Central Plateau, as exemplified by the Cox River area, are found; but further to the south a different type of topography is found. Geological and physiographic conditions right through the area are very complex.

Geology of the Area.

From a geological standpoint the Wollondilly Basin may be divided into two regions—one comprising the Triassic rocks on the north-east, and the other including the Lower Palaeozoic strata on the west and south (Text-fig. 2).

The Triassic area includes Wianamatta Shale and Hawkesbury Sandstone. The shale area represents an outlier, and centres on Moss Vale. The character of the shale differs a little from place to place, but the formation is, as usual, not very resistant to erosion, and the preservation of such a comparatively large outlier on the tableland surface is due to a capping of Tertiary basalt, now largely eroded. This shale outlier is found in a local hollow in the Hawkesbury Sand-



Text-fig. 2.—Geology of the Area. Younger rocks are found towards the north and north-west, those to the west being older. The area between Mt. Werong and Taralga is shown tentatively as Devonian. Basalt areas are numbered after the text. (Based on the Geological Map of New South Wales, 1914.)

stone, and the altitude of its base varies from 2,050 feet at Mittagong to 2,200 feet in the vicinity of Berrima. To the north and west, Hawkesbury sandstones on the plateau surface are found at 2,400 feet and upwards to 2,600 feet near the Wollondilly canyon on the road from Mittagong to Wombeyan. To the south-west of Moss Vale the level of the Hawkesbury Sandstone on the plateau surface rises to 2,500 feet. Observations showed that the level of the base of the Robertson basalts, and of the various basalt outliers to the south and south-west of Berrima is 2,350 feet, or thereabouts. The base of the basalts at Wanganderry lies at 2,400 feet (approx.) above sea level. This general correspondence of levels would indicate that, in this district, the level of the Late Tertiary peneplain surface was of the order of 2,350 feet above (modern) sea level.

In this area the Hawkesbury Sandstone is confined to the eastern side of the Wollondilly River, the topography of the sandstone surface being characteristic of this series.

The most remarkable feature of the Hawkesbury beds is their folding into a syncline a little to the north of this area, over the Nepean River catchment (Text-fig. 12). This syncline would appear to be most pronounced between Bargo and Picton, and it gradually fades out towards the south. In the Moss Vale district a continuation of this fold is possibly seen in the hollow in the Hawkesbury Sandstone in which the outlier of Wianamatta rocks occurs, and a good deal of the present topography of that district has been determined by differential erosion of the Wianamatta shales, as will be explained later.

In this area the Permo-Carboniferous rocks are not very important from a physiographic point of view, because of the smallness of their surface outcrop. These rocks are found along the southern and western edges of the Hawkesbury Series, to which they have a marked resemblance on account of their littoral character. Their thickness increases very rapidly away from the periphery as one goes towards the coast.

The Lower Palaeozoic rocks of the Wollondilly area have been classified for the most part as Devonian and Silurian. They consist of highly metamorphosed quartzites, slates, and claystones, together with some shales and intrusive granites. The general strike is about 10° east of north (magnetic), and they have been intensely folded into symmetrical anticlines and synclines. In the Goulburn district parts of these synclines stand up above the general level of the country as residual peaks, but further to the north the folded rocks have been bevelled off across the bedding planes to form the old peneplain surface. As a general rule the softer rocks occur in the western and southern parts of the area, and are responsible for a more subdued type of topography.

Although large areas of rocks on the northern side of the area have been charted on the official geological map as being Silurian, it seems fairly certain that a strip of Devonian rocks occurs on the eastern edge of the Lower Palaeozoic, stretching from the Mudgee district in the north to Goulburn in the south. At Mt. Lambie and Mt. Walker, and also lower down the Cox Valley, strata of proved Devonian age occur. The two most characteristic types are a glassy white quartzite and a red slate, the two generally being associated. These rocks are found along the general strike line at Gangerang Range (Cox Basin), Mt. Werong and Yerranderie, whilst the white quartzite persists away to the south into the Goulburn and Lake George districts. In the Wombeyan Caves and Taralga districts on the eastern side of the Main Divide there are extensive outcrops of granitic rocks (principally felsites), whilst extensive areas of Tertiary basalts occur on the plateau surface. These interrupt and obscure the metamorphic rocks, which outcrop again to the east of Taralga, continuing thence southwards. Through this southern extension the white quartzite is very prominent, forming low ridges on the more level plateau, and residual peaks on the Goulburn Plains. In the latter district these strata have been identified as being of Devonian age, and there seems no reason to suppose that similar rocks along the same general strike line are of any but Devonian age.

To the south of Mt. Werong, alternate layers of white quartzite and red slate dip westwards, and the head streams of the Abercrombie have eroded shallow valleys and passes in the slates, leaving the harder rocks as well-defined meridional

ridges. Further south, between Marulan and Goulburn, streams have taken advantage of anticlinal folds to cut other north-south valleys, leaving parts of the synclines as residuals.

There are two considerable areas of intrusive rocks in the Wollondilly Basin, in the Marulan and Wombeyan districts. In the first case the main mass consists of grano-diorite and hornblende-biotite-granite, together with small peripheral areas of gabbro. In the second case, as at Yerranderie, the main mass is a very resistant felsite, and gives extremely rough topography. In some parts, however, granite is found, and with it a more subdued topography. An instance of this is found about four miles north-east of Wombeyan, near the great bend of the Wollondilly at Murruin Creek junction.

Going southwards from the Wollondilly into the Shoalhaven Basin older rocks (Ordovician) are met with. The Shoalhaven valley to the east of Lake Bathurst is an extensive level plain, 2,100 feet above sea-level, carved for the most part in folded Silurian strata which offer no great resistance to erosion in most places. Sandstones and very pretty red and mauve shales are found along Windellama Creek and in its vicinity. On the Shoalhaven River, near Nerriga, reputed Ordovician strata occur, whilst to the east of Nerriga, Upper Marine sandstones are met with which extend to the coast near Nowra.

In various parts of the Wollondilly basin considerable areas of Tertiary basalt are found, in general forming part of the plateau surface. The most notable occurrences are in the Taralga and Robertson districts, and many smaller areas are met with, being classified later in the paper. The wide occurrence and relative thickness of these basalt residuals indicate volcanic activity over the whole area, although it is not meant to imply that, at any time, a continuous sheet of basalt has covered the whole (ancient) surface of the area. Practically nothing is known of the mutual relationships of these isolated areas of olivine-basalt, and much geological work will be necessary in this connection.

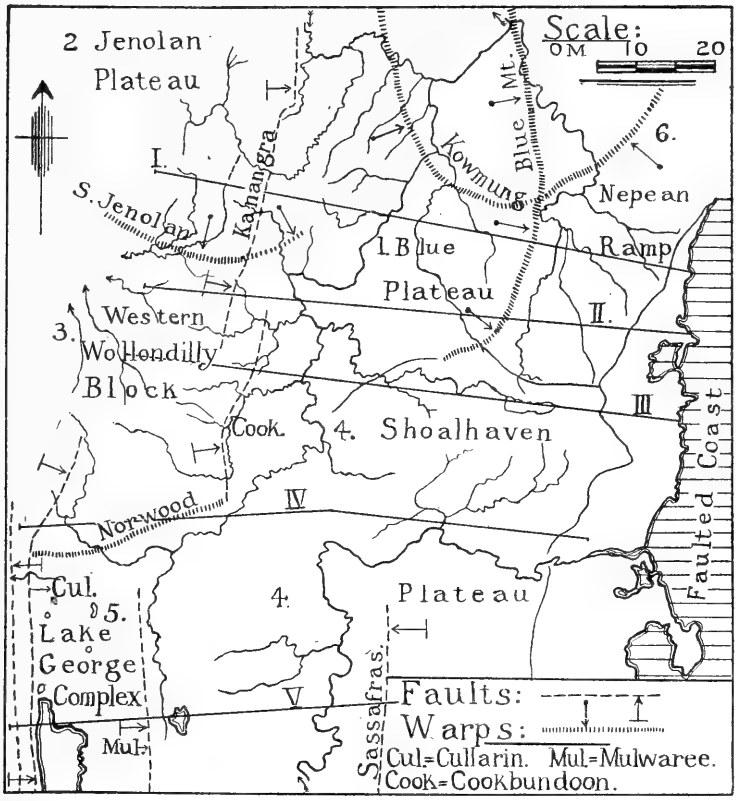
Resistance to Erosion.—Whilst it is quite unsafe to attempt to lay down any hard and fast rules as regards the resistance to erosion of the rocks met with in the area, a few cases of special strength and resistance can be noted.

The most resistant formations are the white quartzites which form part of the Devonian series, and outcrop along meridional lines. In many places these stand up above plain surfaces, and in any case are only eroded fairly readily by streams when underlying weak shales are exposed. The felsite area on the middle Wollondilly is also highly resistant owing to its high percentage of quartz and plagioclase, the relatively small size of its phenocrysts and the glassy nature of the groundmass, factors which tend to reduce mechanical and chemical weathering to a minimum. This intrusion stood up as part of the continental mass during the deposition of the Permo-Carboniferous and Hawkesbury rocks, which flank it on the east and north.

Outstanding weak formations are met with in the case of Wianamatta Shales and the shales and sandstones of the Lower Palaeozoic rocks found in the Shoalhaven valley. The Devonian slates are moderately resistant to erosion, and are, in general, fairly dense and compact. Tertiary basalts which occur widely over the area are marked by great resistance to mechanical weathering, and are more resistant than the slates. In the Taralga district valleys become wider and deeper after passing from basalt to the underlying slates. On the east of the middle Wollondilly and in the Bundanoon district, on the Southern railway, resistant Hawkesbury Sandstones are met with, and have the effect of giving

a more youthful type of valley on the plateau surface than is the case with the slate, basalt, and shale formations.

As one goes westward into the Palaeozoic rocks, as on the Abercrombie and the downs of the Upper Lachlan, the general character of the rocks appears to become weaker. In the former case, to the north-west of Taralga, deep and narrow canyons have been torn by juvenile streams. In the latter case, the topography is generally very subdued. Thus it may be stated that, as a whole, the Devonian rocks are more resistant to erosion than are the Silurian owing to their predominance of quartzites and massive slates.



Text-fig. 3.—Topographic Divisions and Features. Numbered section lines for Text-fig. 12 are shown. Note the meridional and transverse arrangement of the warps and faults. These separate the topographic divisions from one another.

Topographic Divisions.

The Wollondilly Basin falls naturally into several divisions, which are determined primarily by altitude. An old peneplain surface has been differentially uplifted to form plateau blocks of varying elevation. Three of these divisions have been referred to in a previous paper (Cox River Basin), namely, the Blue and Jenolan Plateaus and the Nepean Ramp, and all can be readily followed on the map (Plate xxxix).

The divisions are as follows:—

1. *Blue Plateau (South).*—The Blue Plateau is a sandstone-capped area which has been trenched by swiftly-running streams. The presence of weaker Permo-Carboniferous strata beneath the sandstones has resulted in the formation of great escarpments along the valley sides. The typical features of the central (Cox River) section are repeated in this southern extension, which is drained by the Nattai and Lower Wollondilly Rivers. The altitude of this division varies from 2,000 to 3,200 feet, with a general rise from the north-east to the west and south-west. The surface presents an almost unbroken skyline typical of the upraised peneplain. Here and there it is broken by isolated basalt-capped hills, of which the most prominent are Mts. Colong (3,460 feet), Penang (2,603 feet), Nundialla (2,554 feet), Cumbertine (2,299 feet), and Jellore, a trachyte peak, which rises to 2,732 feet. Another area of basalt occurs at Wanganderry, between the Upper Nattai and the Wollondilly. On the southern side there is a distinct fall away to the Shoalhaven Tableland at 2,300 feet. The Wollondilly and Wingecarribee Rivers run against this southward fall, and are thus antecedent.

On both sides of the Wollondilly to the south of Yerranderie, a mass of intrusive rocks occurs on the plateau surface, being continuous with the sandstones. Both go to form part of the old peneplain surface. The plateau has been trenched by the two series of valleys, the great modern canyons up to 2,000 feet deep, and a series of shallower and more mature valleys incised to different depths in the surface. The Yerranderie valleys are cut to a depth of 800 feet. At Bullio the valleys are 200 feet to 300 feet deep. The valleys of the Upper Wingecarribee also belong to this series.

To the west the Blue Plateau gives place to a higher mass—the Jenolan Plateau.

2. *Jenolan Plateau.*—The southern edge of this section is associated with the Wollondilly area, although the main mass is drained by the Cox, Macquarie and Abercrombie systems. From the Blue Plateau near Yerranderie there is a sharp and definite rise to the Jenolan level at 4,000 to 4,200 feet to the east of Mt. Werong. There is a similar "step up" from the basalt plains around Taralga at 3,000 feet to Mt. Werong, lying to the north. These slopes represent part of the eastern and southern edges of a high dome. From Curraweela (near Richlands) and Wombeyan Caves over a distance of 15 miles there is a uniform rise of 1,100 feet, from 3,100 feet to 4,200 feet, on to the Jenolan Plateau, representing a grade of the order of 70 feet to the mile. Looking across this country from the east or west it appears to be a plain sloping gently to the south. Actually the surface is dissected by narrow valleys and canyons cut by Murruin Creek and the head streams of the Abercrombie, which have eroded right to their divides. These streams, flowing parallel to the rock strike and down the slope, have done far more work than the westward-flowing level streams to the south, such as the Bolong and Crookwell Rivers.

Although many basalt residuals are found on this surface none rises to a height of more than 200 feet above it, and so they do not form important landmarks.

3. *Western Wollondilly-Abercrombie Block.*—Passing to the south of Jenolan Plateau a great uplifted plain is reached. This has an elevation of some 3,000 feet, and is drained by the Upper Wollondilly, Cookbundoon, Crookwell and Abercrombie Rivers. The westward extent of this plain beyond Crookwell is unknown to the writer, but it must be considerable. Looking from the higher

lands to the north, this country appears to be almost absolutely level. For many miles in the undissected portion near the Main Divide the only relief is afforded by occasional basalt hills. The skylines here are level and unbroken, and the streams flow in ancient valleys before plunging into deep juvenile canyons to flow over the edges of the plateau. On the eastern side the streams have bitten deeply into the plateau, but on the west of the Main Divide there is a much greater extent of level country owing to its greater distance from the western edge and consequent remoteness from the head of erosion.

Southwards this block gives place to the lower highlands of the Yass-Lake George-Goulburn district. A certain amount of warping and faulting between these two sections of the plateau is extremely probable. To the east of the Western Wollondilly Block lies the Shoalhaven Plateau.

Along the Main Divide in this section there are notable areas of basalt, whose present extent along the Divide may represent the course of a Tertiary stream down which the lava flowed. This would indicate an entirely different drainage from that at present obtaining.

4. *Shoalhaven Plateau.*—Towards the coast lies the Shoalhaven Plateau, at an average elevation of 2,200 feet. This division extends from Mittagong on the north past Nerriga on the south, and from the Illawarra scarp inland to Goulburn and Lake Bathurst. This section is broken by two higher blocks, Sassafras Range and the hills around Robertson, both rising to 2,700 feet. The former is a horst which is prolonged southwards by the Budawang Range (Currockbilly Mts.), whilst the extra elevation of Robertson is due to sheets of basalt 350 feet thick which have been poured out on the surface of shale at 3,350 feet.

Geologically, the Shoalhaven Plateau can be divided into two sections, Triassic rocks occurring to the north of the Lower Shoalhaven, and Lower Palaeozoic strata, together with some Upper Marine beds, being found to the south. All of the older rocks have been intensely folded, and bevelled off across their bedding planes to form a plain which is co-extensive with plains of horizontally-bedded young rocks to the north. The Upper Marine beds have not been greatly warped or folded.

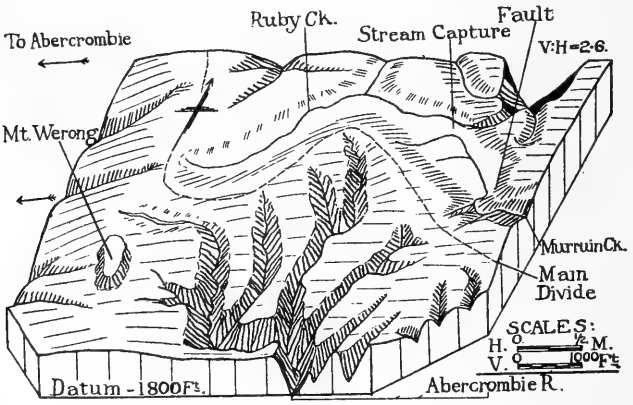
With the exception of the quartzite residual country in the Marulan and Goulburn districts the western part of this division presents an even appearance. The streams have not yet dissected the greater part of the plateau surface, only the Lower Shoalhaven and some of its tributaries being deeply entrenched. In general the stream valleys are very shallow and are late mature in type.

5. *Lake George Complex.*—Between the Western Wollondilly Block and the Canberra-Gourock Highlands there is an area of comparatively low country crossed by meridional ridges and faults. The continuity of the higher plateaus is broken by this "geocol". Around Bredalbane and Lake George there are extensive plains at an elevation of 2,300 to 2,400 feet, corresponding to the slightly lower levels of the Shoalhaven Plateau to the east and the downs of the Upper Lachlan to the west. The western boundary of the Lake George Plains is a long narrow horst—the Cullarin Range—rising to 2,700 feet. The Molonglo and Upper Lachlan Rivers have cut gaps and passages through this horst, but other streams have been blocked and betrunked to form Lake George. On the eastern side these plains are bounded by another high, narrow ridge, which has been cut across by numerous small streams. Commencing six miles to the south-west of Goulburn this ridge rises fairly rapidly above the level of the plains, attaining an elevation of 3,227 feet at Mt. Allianyonyiga to the west of Tarago railway station.

This ridge extends far to the south, passing into the Gourock Ranges. It appears to be a combination of residual ridge and horst. Other ridges and residuals mark the plain near the northern shore of the lake.

Structurally, the Lake George Plains and allied plains on the head of the Lachlan form the trough of a syncline between the highland masses to the north and south.

6. *Nepean Ramp.*—From Botany Bay to Robertson the land surface rises steadily forming an inclined plane or "ramp", which has been dissected by such consequent streams as the Avon, Cataract, Cordeaux, George's and Woronora Rivers. The surface slopes down from the Illawarra coastal scarp to the north-west, forming a syncline with a north-south axis. The surface consists of Hawkesbury Sandstone in which the streams, rising almost at the coast and flowing inland, have scored gorges some 500 feet deep. The inland slope ends against the eastern face of the Blue Mountain Monocline, which extends in this section from Wallacia to Mittagong. The downward northern slope of this ramp is continued in the southern section of the Blue Plateau further to the west. Owing to its extreme roughness this country can only be traversed with difficulty, and most of it is a water reserve.



Text-fig. 4.—The Mt. Werong District. The upper valleys of Ruby Creek (Kowmung System) and Murruin Creek are being attacked on all sides. The upper part of Ruby Creek—Lannigan's Swamp—originally flowed to Murruin Creek. Deposition of alluvials along this valley is the result of faulting.

Summing up, it is seen that the Wollondilly area consists of a number of distinct and somewhat dissimilar sections. The essential plain character of most of these sections suggests that they were, at one time, co-extensive, and have been more recently separated by differential uplift. A further study of the area supports this view.

Features of Special Interest.

1. *Mt. Werong.*—"Werong" is the name given to a small rounded basalt hill located some twenty miles due south of Jenolan Caves (Text-fig. 4). The Main Divide runs close by, and is here very indefinite. The mount itself is very little above the flat swampy plateau relic on which it is located. To the north lies the main mass of the Jenolan Plateau, which rises to 4,400 feet around Shooter's Hill.

Southward, as far as the eye can see, stretch the plains of the upper Abercrombie and Wollondilly Basins. Long, low ridges of much-eroded basalt hardly break the even surface, and the deep canyons that scar the country are marked only by faint lines.

The Werong area at 3,800 feet is a "step-up" from the Western Wollondilly Block at 3,100 feet to the Jenolan Plateau at 4,400 feet. The locality is one of great geological and topographic interest.

Tributaries of three streams head at this point—namely Abercrombie River and the Werong Branch, Murruin Creek, and Ruby Creek which flows to the Kowmung. The Abercrombie streams have cut steep canyons right to their divides, but a couple of miles of undissected country remain along the heads of the other two streams. A higher ridge, across which Ruby Creek breaks, bounds this area on the north, separating it from the Kowmung Canyon. The land to the south-east of the Mount is also somewhat higher, consisting as it does of hard quartzite ridges. Passing south of the Mount from the Murruin and Ruby Creek areas the ridge-tops between the Abercrombie streams have a gentle, definite slope south.

Around the Mount, especially on the north-eastern side, the plateau valleys are flat and late mature, and sub-divides between the streams are represented by ridges rising 30 or 40 feet above the surface of the swamps. The whole of the level area between these ridges is covered with alluvium of doubtful depth, but whose thickness at the head of erosion on Murruin (or Limeburner's) Creek would appear to be not less than 40 feet. Two series of alluvials have been noted, both of which carry gold.

The lower and less extensive level has been formed as the result of terracing of the upper and more extensive level by stream action. The latter lies between 3,750 and 3,800 feet, whilst the surface of the former is from 10 to 30 feet below the lower parts of the upper terrace. The alluvials form a continuous line along the upper parts of both Ruby and Murruin Creeks and the upper level part of the former stream flowing on the tableland has been captured from the common line by the steep, swiftly flowing stream cutting back from the Kowmung side. Thus Ruby Creek leaves the level valley and plunges into a narrow gorge cut in the high northern ridge (Text-fig. 4). The basalt of the Mount has not, apparently, been poured out over these alluvials; although now, apart from the basalt area comprising the Mount itself, there is only a small kaolin deposit occurring on quartzite some 30 feet above the level of the alluvium. A patch of basalt also occurs immediately to the east of the Mount and may, in Mr. Grove's opinion, overlie a patch of alluvium at a slightly lower level than the base of the Mount. The late mature valleys which are a feature of this surface are obviously post-basaltic in age.

The geology of this section is very interesting. The rocks are chiefly metamorphic in character, quartzite, breccia, red and grey slates and metamorphic grit being prominent. The strata resemble the Devonian beds of Yerranderie and the Cox Valley very closely. The earth movements of the Kanimbla Epoch affected the region greatly, and were accompanied by intrusions of acid granites. The rocks have a strike of 10° east of north (magnetic), and have been planed off to form the Tertiary peneplain, in a shallow valley excavated on which the alluvial beds are deposited. Gold occurs sparsely in the grits and breccia, and has been concentrated somewhat in the lower parts of the soil as a result of weathering of the surface rock.

On the eastern side the alluvials end abruptly against granite and massive conglomerate. This is, apparently, due to the development of a fault across Murruin (Limeburner's) Creek, with a downthrow to the west. Excavations for mining purposes have shown that the conglomerates are fractured along a line which dips east at approximately 20°, and are sheared off against a granite surface in places. The higher upthrust side of the fault to the east has caused the partial blocking of Murruin Creek, and the deposition of the series of alluvials along Ruby and Murruin Creeks. As the stream has worn through the uplifted rock mass it has begun to trench the level valley and cut away the sediments. The capture of the former upper part of Murruin by Ruby Creek is assisting in the obliteration of the upland valleys.

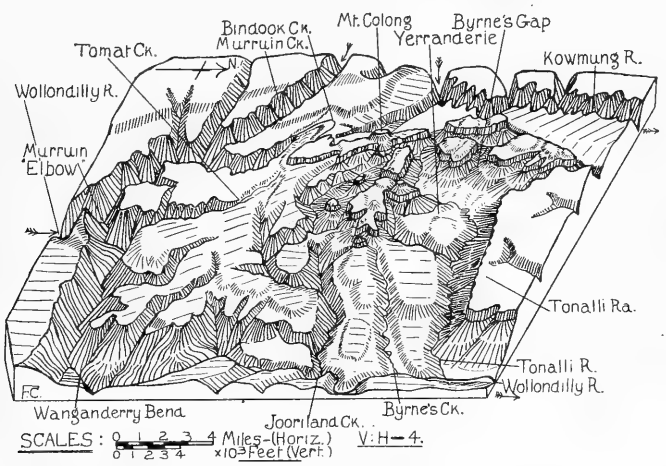
2. *Burragorang Valley.*—"Burragorang" is the name given to the lower thirty miles of the valley of the Wollondilly, which represents a distinct physiographic type. The valley, which is almost straight, is bounded on the east by great escarpments of Hawkesbury Sandstone which are also found on the western side between the Cox and Tonalli Rivers, but to the south of the latter stream the western valley wall consists of massive granitic rocks. The distance between the eastern and western sandstone scarps to the north of Tonalli River is approximately four miles, which represents the general width of the valley upstream to the Wanganderry bend. Below the Tonalli the valley narrows considerably, the average width between the Nattai and Cox junctions being of the order of two miles. Below the latter junction the valley continues to narrow, the last ten miles of the (Warragamba) gorge being almost precipitous.

Burragorang thus appears to be a great trench, whose sides are notably broken in three places only, where the Tonalli and Nattai Rivers and Lacy's Creek fall into the Wollondilly. The latter two valleys are of the same general form as Burragorang, and are bounded by precipices, their lower courses being flat-bottomed.

The structure of the floor of the main valley is very interesting. Between the Cox River and Byrne's Creek the greater part of the floor is composed of silt flats, part of which has been described in an earlier paper, where three terraces were recognized near the Cox junction at 160, 180, and 220 feet above sea level. In general, however, such series of silt terraces are not readily recognized in the valley, although there is a distinct rise in the silt flats as one proceeds up the valley. Thus at the Nattai junction these are found at 250 feet, and at 350 feet above the sea ten miles higher up, at the mouth of Byrne's Creek. On the eastern side of the valley opposite the junction of Tonalli River a great bed of old river gravel is found on the talus slope from 50 to 75 feet above the modern silt flats on the river at 350 feet. These gravels are readily distinguished from the rounded sandstone pebbles typical of the talus slopes by the variety of rock types found in them, and they mark the position of an old river bed. They indicate clearly a slight lateral movement of the channel of the river and some vertical erosion in stages. The width of the silt flats varies between a couple of hundred yards and three-quarters of a mile. They are continuous between the Cox River and Byrne's Creek, but above the latter point flats are only met with occasionally on a concave bend of the river or at the mouths of creeks. No silt flats of any consequence are found above Wanganderry bend, the few sidings that are met with above that point being very narrow and limited in extent.

The depth of the valley varies from 1,400 feet near the Cox to 1,700 feet at the Nattai, which depth continues until the Tonalli River is reached. Above this

point a definite "valley in valley" form is recognized. The entrenchment of the Wollondilly in the plateau increases somewhat to 1,900 feet at Wanganderry bend, but the topography of the valley undergoes a distinct change. The river no longer flows in a flat-bottomed valley, but in a gorge of increasing depth (Text-fig. 5). A distinct level up to two miles in width forms the floor of the main valley, which varies in altitude from 700 feet near Tonalli River to 1,300 feet near Wanganderry bend. There is not an absolutely uniform rise between the two points named, but the greater part of the floor lies between 900 and 1,100 feet above sea level. The Wollondilly has cut a precipitous gorge in this valley floor up to 700 feet deep, and the lower courses of its small tributaries are also deeply entrenched. The northern part of the old floor lies on the western side of the river, but the southern section lies to the east of the Wollondilly. The greater part of the terrace is composed of granitic rocks, including porphyritic quartz-felsites and felspar-porphyries, but a part also consists of sedimentary rocks, presumably Upper Marine sandstones. The surfaces of the two rock types are co-extensive.



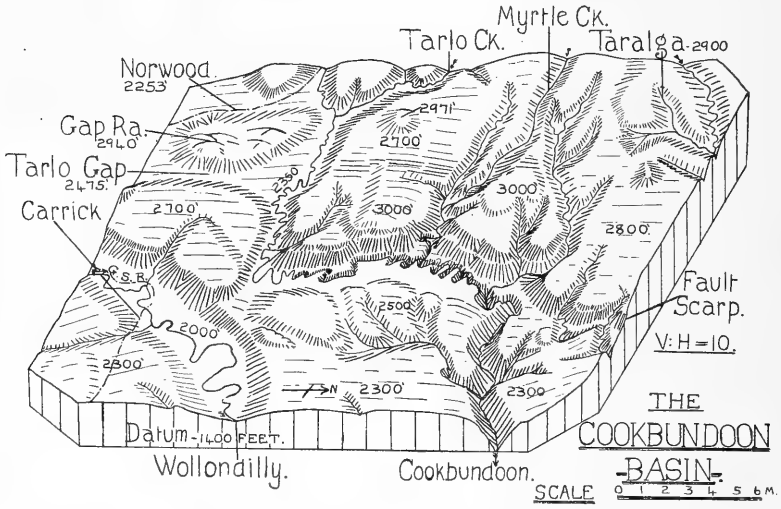
Text-fig. 5.—The Yerranderie District, showing the valleys of Tonalli River and Upper Burragorang. Note the terraces in the foreground and the change in valley section upstream from Wanganderry Bend. The outliers of horizontal rocks around Yerranderie mark a former continental edge.

The fact that the hardness of the rocks forming this terrace varies considerably indicates that the terrace was formed at a temporary base-level, and subsequent uplift to the south has caused the terrace to slope downwards from the south to the north. Subsequently the modern smaller canyon of the river has been incised in the old valley floor. The idea of stages of uplift is supported by the terracing of alluvials in the lower part of Burragorang, and the occurrence of old river gravels as noted well above the modern channels.

3. *The Tonalli Valley.*—The valley of Tonalli River (Text-fig. 5) is the only great break in the side of Burragorang. The position here is very interesting, as the stream has cut along an old continental margin. To the south there is a great mass of felsite which is very resistant to both mechanical and chemical erosion. The small streams to the south of Tonalli River have cut short, steep gorges in the hard mass. To the north there is a great thickness of sub-

horizontal sedimentary rocks. At the head of the stream, to the west, these rocks are 700 feet thick, and thin out rapidly to zero to the south-west and south at the Bindook Pass and the head of Tomat Creek. But on the north the sedimentary beds reach a thickness of 1,900 feet. Right against the old granitic mass these rocks consist of resistant grits and sandstones, but to the north the Coal Measure and Upper Marine beds consist largely of soft shales and crumbling sandstones. The softness of these rocks has doubtless contributed to the erosion of such a wide valley along the lower part of the Tonalli, but it must be understood that similar, although narrower, mature-looking valleys have been incised in the uniformly hard rocks around Yerranderie.

The floor of the main valley rises gradually from the bench in Burragorang to Yerranderie at 1,900 feet. The latter levels are also found in the Kowmung Basin, north-west of Yerranderie and along Colong Creek. The gaps and passes between the Tonalli Valley and the Kowmung and Colong Creek drainages have been cut down to the valley level. Masses of hard sandstones have been isolated by the cutting action of the streams, and appear as precipitous-sided residuals.



Text-fig. 6.—Basin of the Cookbundoon River. The Wollondilly River flows in a mature valley below the level of the Cookbundoon. The higher plateau to the west is being attacked by streams which are eating back into the fault scarp. See also Text-fig. 8*d*.

The valleys of the Yerranderie levels are not found in any one particular geological horizon. Around Yerranderie itself they are cut to a depth of 200 feet in Devonian metamorphics and felsite. The upper valleys of Colong Creek and its tributaries are eroded in horizontal Permian sandstones, whilst the heads of Black Hollow Creek running in the wide upland Kowmung Valley are cut partly in Permian sandstone and partly in quartzite and red slate. It appears, then, that the valleys around Yerranderie about the 1,800 feet level have been cut at some constant base-level. The great width of the lower Tonalli Valley is doubtless due to the rapid erosion of soft underlying shales, but it does not seem probable

that the sloping valley floor could have been cut under existing conditions, nor could the level valleys around Yerranderie have been formed at their present level. Headward erosion along Black Hollow and Jooriland (Colong) Creeks and Tonalli River is causing these valleys to become dissected. The asymmetry of the Tonalli Valley is due to the highly-resistant character of the granitic rock which forms its southern side. The conclusion arrived at is that the present disposition of the Tonalli Valley system represents some of the effects of the "Kowmung Warp", the original slope being warped upwards towards the south and west.

4. *The Cookbundoon Basin.*—The Cookbundoon is the only large tributary of the Upper Wollondilly River, and its system consists of four large creeks, namely Tarlo Creek, or the Cookbundoon River, and Myrtle, Kerrawary and Junction Creeks. With the exception of the last-named these streams flow from the Western Wollondilly Block (Text-fig. 6). This surface at 2,700 to 3,200 feet represents one clear level, the other being part of the Shoalhaven Plateau at 2,300 feet. The streams, with the exception of Junction Creek, rise in the gently-rolling basalt hills between Roslyn and Taralga, and flow over a subdued land surface.

Between Roslyn and the little village of Tarlo, on the Goulburn-Taralga road, the valley of Tarlo Creek is mature, falling gradually from 2,800 to 2,350 feet, but the greater part lies near the lower level. Thus the stream is entrenched 400 feet in the highland block. Below Tarlo the stream valley becomes restricted and its floor narrow and broken, and from here onwards the stream falls rapidly. The greatest width of this valley floor is at Tarlo, where it is upwards of two miles wide. Near the great bend below Tarlo the stream becomes more deeply entrenched in the highlands until its emergence from a great scarp. Here the stream deserts its easterly course and turns to the north, becoming entrenched in a deep narrow canyon which has been cut in the 2,300 and 2,400 feet levels. On Swallowtail Pass, near the mouth of Junction Creek, the gorge is 900 feet deep and has almost precipitous sides. The courses of Myrtle and Kerrawary Creeks are similar to that of the main stream, but the valleys are shallower towards their heads and have a more juvenile character near where they cross the scarp. The parallelism of Myrtle Creek with its main tributary, Murrang Creek, is striking. It seems probable that the valley of a Tertiary stream has been filled with basalt and these two streams have been developed, one on either side of the flow, and have maintained distinct courses. Junction Creek is shorter than the other streams, but its valley is very mature, and the stream itself is broad and swampy to within a mile of the steep Cookbundoon Canyon. The Wollondilly flows on the south-eastern side of the Cookbundoon Basin in a flat-bottomed valley whose width varies from one to two miles. Here the river flows about 2,000 feet above sea level, and is 300 feet below the floor of the valley of Tarlo Creek.

The topography of this section is fascinating. On the western side the basalt ridges of the Roslyn-Taralga section rise to 3,390 feet along the Main Divide and form the highest part of the Western Wollondilly Block. From here there is a definite slope to the east to 2,700 or 2,800 feet along the middle courses of the eastward-flowing streams, but still further to the east, above the Cookbundoon Scarp, there is a rise to 3,000 feet in an area of harder rocks. This higher area is narrow, and is bounded on the eastern side by the great scarp, where the land falls away to the level of the Shoalhaven Plateau. East of

the great bend of the Cookbundoon, hills, covered with a screening of basalt, are found at 2,500 feet, but these give place in the north and east to level plains. The gap between the Wollondilly and Cookbundoon is fairly level, and consists of slate and quartzite. Two other air gaps are found on the southern divide of the Cookbundoon, near The Forest railway station at 2,550 feet, only 100 feet above Carlo Creek, and on the Taralga-Goulburn road, the latter being known as "Tarlo Gap", and situated at 2,500 feet, or 150 feet above the stream. Both appear to be due to the erosion of softer rocks from between hard layers of quartzite.

To the south of the Cookbundoon Basin there is a gentle fall-away towards the Upper Wollondilly above Goulburn. Sooley Creek and other wet-weather streams flow down this slope. On the northern side the topography at Bannaby deserves notice. The Cookbundoon is entrenched in a "saw-cut" gorge entrenched in a plain at 1,950 feet. This level is continued westwards until a steep rise is reached leading to the village of Bannaby situated on rolling downs at 2,400 feet. Bannaby Creek flows towards the village from the west at an elevation of 2,500 feet until it plunges downwards towards the lower lands through a steep little gully. The upper part of its valley is mature in type, and heads against a steep hill (Bannaby Hill) seven miles east of Taralga. This corresponds to the upper valleys of the Cookbundoon streams to the south.

The upper valleys of Taralga Creek also show the typical features of the Cookbundoon streams, rising in mature basalt valleys about 2,900 feet and pursuing mature courses for a time before plunging into juvenile valleys and flowing down to the lower levels. Across the Main Divide to the west of the Cookbundoon Basin the tributaries of the Abercrombie flow in very flat valleys which have not been trenched as have the valleys to the east.

The course of Tarlo Creek and the Cookbundoon River is marked by the presence of well-developed meanders, some of which are on the level valley floor, whilst those on the downstream side are deeply entrenched. These latter could hardly be formed under present conditions, and they appear to date back to the time when the lower part of the stream flowed over level plains, or at least over such a valley floor as is preserved along Tarlo Creek, and which is favourable to lateral stream erosion and the development of meanders. The presence of these features would indicate a considerable age for the whole stream line, and consequently the peculiar relationship of the "elbow" of this stream with the Wollondilly also. The evidence appears to indicate that this stream system has not changed greatly in outline since the beginning of the plateau uplift.

5. *Upper Wollondilly Valley.*—A study of the valley of the Wollondilly (Plate xxxix) discloses striking changes in valley form. From the head of the stream at McAllister to Goulburn, a distance of 35 miles, the river flows through an adolescent to early mature valley which becomes wider gradually on the Goulburn side and attains a maximum depth of 500 feet in the upper section. During the lower 16 miles of this upper course the river falls gently, and swings round in a wide bend changing its course from a southerly to an easterly direction. This sweep brings the river close to the upper waters of the Lachlan, and narrow ridges divide it from the plains of Bredalbane. At Goulburn the Mulwaree comes in from the south after passing over the level Goulburn Plains, which represent part of the Shoalhaven Plateau and the old peneplain level.

Below Goulburn the river flows between the high residual hills of Governor and Towrang on the south-east and a great scarp 500 feet high on the north-west.

The course of the stream lies over a level plain from a half to two miles wide, and is marked by a very slight grade and extensive alluvial flats. Near Towrang an old bed of the river is indicated by rounded pebbles on the plain 50 feet above the modern river and its silts. This phase continues for three miles past Carrick, where the river runs into a short steep canyon, a mile and a half long and 400 feet deep. The closing in of the steep sides of the gorge compels the roads to leave the river and seek higher passes through the hills on either side. The great narrowing of the valley at this point is due to the occurrence of a belt of dense acid granite and porphyry across the course of the stream. At the end of this narrow section below the little village of Longreach the valley again becomes wide and flat-bottomed for a distance of eight miles. Here it is a mile and a half wide and 300 feet deep, with a very sandy floor. In places on either side the plateau is capped with rather weak horizontal sandstone and conglomerate, 50 to 100 feet thick and 2,300 feet above the sea, which form low, broken cliffs. Two miles below this section the junction of Paddy's River is reached. Rejuvenation has affected the river here, and a steep gully 150 feet deep has been cut in the upland valley. The upper valley continues for some miles downstream until all trace is lost in the widening and deepening canyon.

Between this upper valley and Burragorang the Wollondilly flows through a precipitous canyon cut in dense granite and felsite. Neither the upland valley nor the terraces of Burragorang are seen in this canyon, the latter ending sharply above Wanganderry Bend. Ancient meanders of the river have been preserved above Murruin Elbow, and these serve to differentiate the Upper from the Lower Wollondilly.

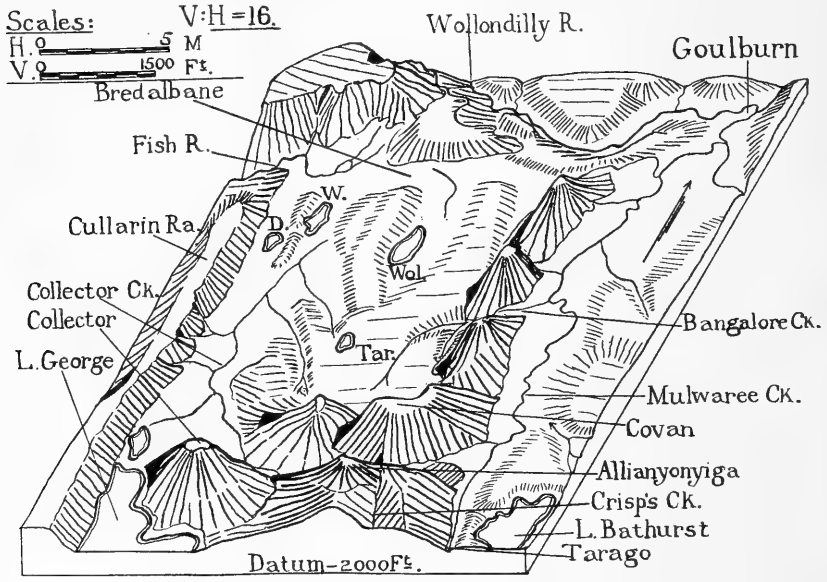
In the upland valleys, especially between Goulburn and Paddy's River, the course of the river is marked by well-developed meanders which have been formed as the result of lateral erosion on the wide, flat valley floor. Rejuvenation on the downstream side has resulted in the lower course of the river becoming entrenched, and this rejuvenation has affected the river slightly almost to Goulburn, causing a slight increase in velocity.

Three distinct stages of valley development have been recognized, namely, the adolescent to early mature valleys above Goulburn, the flat-bottomed valley below Goulburn extending to Paddy's River, and the lower juvenile canyons. Besides these the Goulburn Plains have been mentioned. The first series is based on the 2,000 feet level; the second occurs between 1,850 and 2,000 feet, being a continuation of the first; whilst the juvenile canyons have as a base-level the plains of Penrith. Thus it appears that the uplift of the plateau in this region has taken place in two stages, allowing the formation of the upper valleys of the Wollondilly incised 400 feet and more in the old peneplain, and the modern gorges.

6. *Bredalbane Valley.*—Between Goulburn and Gunning the Southern Railway takes advantage of a gap in the Main Divide and passes over Bredalbane Plains. Situated to the south of the Wollondilly River the valley of Bredalbane represents the northern part of the Lake George area, for it is here that the dividing line between eastern and western waters bifurcates to enclose the Lake George and other smaller inland drainage areas.

Going westwards from Goulburn the plains along Mulwaree Creek are left behind near Yarra and a small valley, through which the Run of Waters flows, leads up to wide plains over which a small creek flows into Wologorong Lagoon (Text-figs. 7, 8). To the west the floor of this valley narrows somewhat at

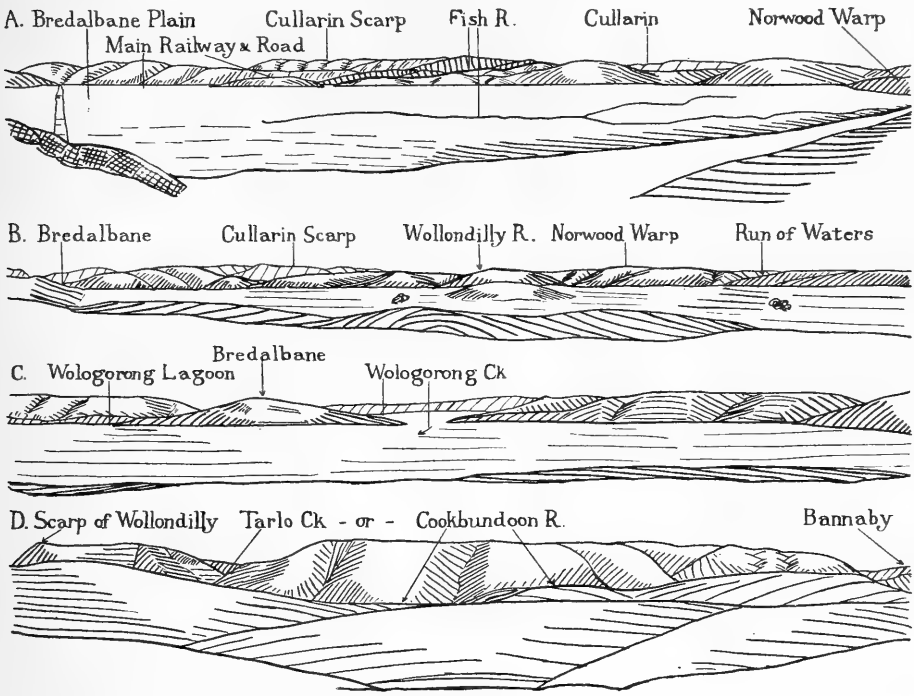
Bredalbane railway station, and past here a small, ill-defined creek gives a run-off to Fish River, which forms the head of the Lachlan. In this western section between Bredalbane and Cullarin Range flat grassy plains are found, but the small stream runs into a high scarp at Cullarin through which it has cut a narrow trench 400 feet deep. Thus three miniature drainage schemes are represented, Wologorong Creek having no outlet into a river system.



Text-fig. 7.—Lake George Area and Bredalbane Valley. The Cullarin fault-scarp continues to the west of the Upper Wollondilly River. Fish River is antecedent, but other streams have been blocked by the rising fault to form Lake George. W = Wet Lagoon; D = Dry Lagoon; Wol. = Wologorong Lagoon; Tar. = Tarago Lagoon.

On the northern side of the valley fairly high hills form the dividing ridge, but on the south the valley is prolonged to the plains of Lake George. The average elevation of Bredalbane Plain is between 2,250 and 2,300 feet, and there is little difference between the three sections; but they are clearly differentiated from Goulburn Plains at 2,130 feet. The area draining into Wologorong Lagoon is very level, and hills rise rather abruptly from the plain, which is covered with water during wet weather. Wash from the surrounding hills has been gradually building up the floor of the lagoon. The silt lake thus formed consists of rich soil, and is used for farming. The fact that Run of Waters is cutting back fairly rapidly from the east is evidence that the lake basin is a temporary feature of the topography, and as there is no evidence of a very thick deposit of wash on its floor we may say that it has been formed comparatively as the result of a local relative depression. The low ridge separating this central lagoon area from other streams on the east and west has been cut through on both sides, thus making the disappearance of the plain imminent and inevitable. Run of Waters, having a fall of 150 feet to Mulwaree Creek, has a distinct advantage in grade

over the level streams going to Fish River. The latter have been partially blocked by the rising of Cullarin Range, thus allowing the formation of a silt lake in front of the scarp. This flat plain is still imperfectly drained. The head of Fish River is thus an antecedent stream, and Wologorong Basin has been formed by uplift either to the east or west. On the whole it seems that the former is more probable, as evidence is in favour of a physiographic fault between this area and Goulburn Plains (Fig. 12).

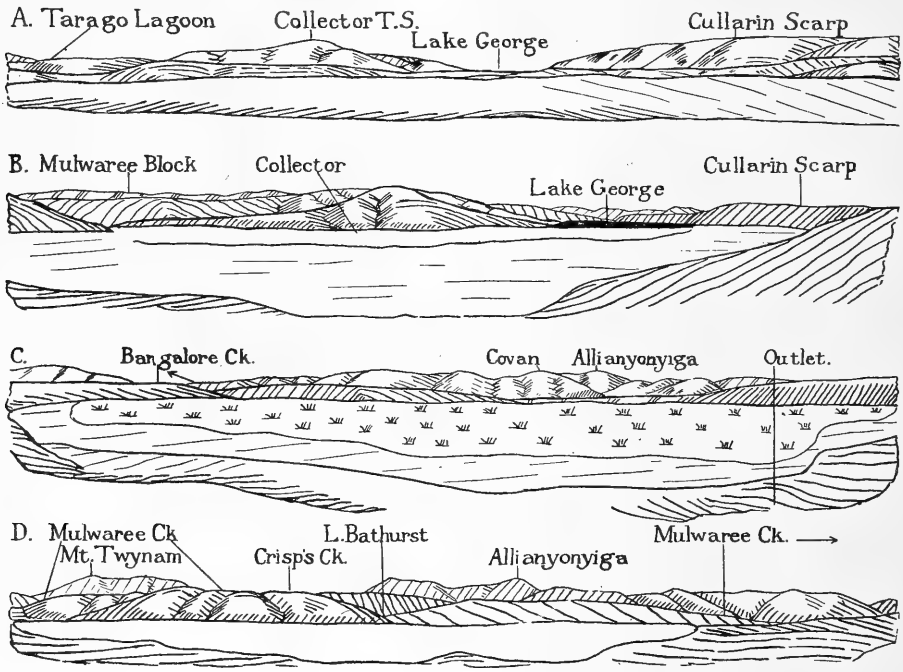


Text-fig. 8.—*a*. The Cullarin fault-scarp west of Bredalbane. View looking west. *b*. Bredalbane Valley, showing the silt lake along Wologorong Creek, which flows in the middle-distance towards the right. Looking north-east. *c*. Wologorong silt lake, looking north-west from the Goulburn-Collector road. *d*. Cookbundoon fault-scarp from near Greenwich Park station. View looking north-east.

7. *Lake George Area.*—Continuing south of Bredalbane Plains a very complex district is entered. The principal plains or valleys run from north to south and are crossed by high ridges and interrupted by residual peaks. Text-figures 7, 8, and 9 show the great diversity of topography.

To the west of the Main Divide the rolling downs of the Upper Lachlan Basin are found east and south-east of Gunning. Cullarin Range presents a low, broken scarp on the western side, but its eastern face is higher, straighter, and more definite, defining the limits of the Lake George Senkungsfeld very clearly. In the vicinity of the lake this scarp is practically unbroken, but further north, in the vicinity of the Fish River water gap it has been more dissected. Indeed the more southern section appears to be younger than the northern.

Eastward of Cullarin are the plains draining to Lake George, the lake itself occupying a local depression. The plains are found at an altitude of 2,300 to 2,350 feet and are remarkably level over their whole extent, the divide between the lake drainage and Bredalbane Plains being almost imperceptible. The plain is interrupted to the south-east of Bredalbane by low ridges rising a hundred feet above it, but these extend only over a couple of miles. Further to the east Wologorong Lagoon occupies a local depression between north-south ridges. From



Text-fig. 9.—*a*. Lake George from the north. Note the typical conical outline of Mt. Collector, which contrasts with the rectangular form of the Cullarin Scarp. *b*. Lake George from the north-west. Note fault-scarps to right and in background, and old residuals. *c*. Tarago Lagoon. Typical of the small lagoons on the plains near Lake George. View looking south-east. *d*. Lake Bathurst. The view shows the eastern bay. Note the broken scarps and the great gap in Mulwaree Scarp (background). View looking west.

the plain near Tarago Lagoon at 2,450 feet there is a steady slope into the Wologorong depression at 2,300 feet, the small plain south of Tarago Lagoon forming quite a distinct level which corresponds to other plain remnants in the vicinity along Bangalore and Crisp's Creeks, the latter flowing south-east from Mt. Allianyonyiga. Both of these small streams drain to Mulwaree Creek, and a low meridional ridge separates them from the Lake George drainage.

Eastwards of these small plains rises the high ridge extending from Yarra southwards past Mt. Allianyonyiga, which presents steep faces on either side, and whose eastern scarp forms the boundary of Goulburn Plains. This great ridge is cut across by several very small creeks, and it presents a striking contrast to the

low eastern branch of the Main Divide to the west of Bangalore Creek. The ridge is composed of highly-resistant quartzite and granite, whilst on the plains of Bangalore Creek shale is met with. The natural features of the residual ridge would appear to have been accentuated by faulting, giving rise to such features as Lake Bathurst and possibly the Wologorong depression. The ridge passes southwards into the high block faults of the Gourock Ranges.

The streams cutting through this ridge would be classed as antecedent. The reason for their original courses into the higher mass is probably found in the manner in which all these blocks of hard rock have split up in past geological time. The tendency has been for resistant outcrops to weather into a chain of separated peaks, this being shown in the district by such peaks as Collector and Terramungula near Lake George, and Mt. Towrang and its associated peaks in the vicinity of Goulburn. The gaps between the original peaks are gradually enlarged and made more level, and are eventually occupied by streams. The cause of these gaps may be found in local fracturing of the rocks during the original folding movements of the Kanimbla Epoch.

The higher plain relics at 2,450 feet drain on to the lower lands over mature valleys on the western side, or through rather juvenile gullies to the east, through the high ridge.

The plains around Lake George are marked by several high quartzite residuals such as Collector (Text-fig. 9), Terramungula, and Currowang (Text-fig. 7). Their conical shape differentiates them from the more rectangular outlines of the fault blocks. Lake George itself has been formed as the direct result of the uplifting of Cullarin Range (Taylor, 1907).

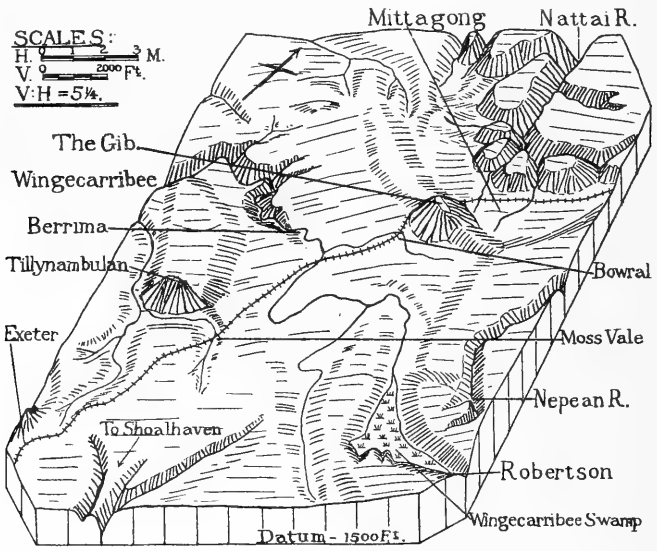
On the Lake George Plains four lagoons are found. Wologorong occurs in a local depression; Tarago is perched on the edge of a high plain, and drains into Collector Creek during times of overflow by a wide valley; Wet Lagoon is just on the low divide between the Lake Plains and Fish River; whilst Dry Lagoon occupies a rather similar position a little further to the south. In each case the presence of the lagoon would appear to be due to slight folding or warping in the plain surface interrupting the former weak and indefinite drainage of the country by forming local depressions. The ease with which this could be done is appreciated when it is realized that there is a fall of less than 50 feet between Wet Lagoon and Lake George, a distance of 9 miles.

The lake and its surrounding plains—all of which are covered with a thin veneer of recent wash—are due to the rising of Cullarin Range across the surface of the uplifted peneplain, of which the plains themselves are an essential part. The sharp "boathook" bend southwards, evidenced by such streams as Collector Creek, may be ascribed to the fault-block turning them aside from a former drainage to the north-west to Fish River. The steep line of hills found to the north of Bredalbane Valley—the northern extension of these plains—is described later as a sharply-warped or a faulted surface.

a. Lake Bathurst (Text-fig. 9).—This small lake has been described by Taylor (1907), and its origin appears to be traceable to faulting. Uplift in the vicinity of Tarago railway station has caused Mulwaree Creek to cut an early mature valley to a depth of 100 feet in the foothills of the residuals and possible fault area of the Mulwaree Block immediately to the west. A small tributary coming from the east appears to have been held up by uplift around Tarago, and has formed Lake Bathurst, whose outlet into Mulwaree Creek is through the rather narrow valley cut into the rising land by the tributary.

8. *Wingecarribee-Nattai.*—The Wingecarribee River rises at Robertson and flows westwards through an extensive swamp in basalt and Wianamatta Shale country to level plains at Moss Vale. Between the syenite mass of The Gib (Mt. Gibraltar) and the basalt residual of Tillynambulan the stream flows over the floor of a wide valley, coming down to the Hawkesbury Sandstones at Berrima. The whole of its upper course thus lies through swamps or over level valleys, but below Berrima the stream is running into higher sandstone country and becoming entrenched in deep canyons, through which it runs to the Wollondilly, its mouth being in granite country.

Flowing from the plains of Moss Vale to the higher sandstone country the river is distinctly antecedent. Other streams of this nature are found near Mittagong, the principal being the Nattai River and Gibber Gunyah Creek (Text-fig. 10). These flow into uplifted and folded sandstones, whilst the Winge-



Text-fig. 10.—Northern edge of the Shoalhaven Plateau, showing rising ground to the north and north-west. This area of ancient topography is being attacked by streams on all sides.

carribee runs from shale plains into a warped sandstone surface which rises to the west. At Mittagong the scarp into which the streams run has been formed by recent folding or faulting, but the more southern slope of the Wingecarribee area does not appear to be a continuation of this folding. The wide valleys of the Upper Wingecarribee may be due to comparatively rapid erosion of the Wianamatta Shale—the lower course of the stream being in resistant sandstones, and consequently in narrow valleys. The greater uplift which took place further to the west may have had some effect on the valley types.

The presence of extensive swamps along the Upper Wingecarribee is remarkable. On various parts of the plateau surface small areas of swamps are found, but some special explanation is required for the case in point. At first I was inclined to think that uplift of land along the lower course of the stream had

caused partial blocking of the water, but the presence of very level and dry plains around Moss Vale, together with absence of any distinct evidence of warping or folding rather discounted the idea. The swamps, which extend from 2,400 feet near Robertson to 2,240 feet on their lower side at Sheepwash Bridge, are mainly on Wianamatta Shale, which is overlain by basalt. This shale weathers into a very stiff clay which is almost impervious to water: but the overlying basalts occur in columns and admit water much more freely. Rain falling on the hills soaks into the basalt soil, and percolates downwards until it meets the underlying clay and shales, through which it will not pass so readily. For this reason it soaks along near the top of the impervious strata, and seeps out along the floor of the main stream valley. The watertable thus comes to the surface of the ground causing swamps which are not found outside the limits of the basalt flow. The base of the basalt is found at 2,350 feet or thereabouts, but it cannot be determined readily in most places on account of a thick screening of soil.

Physiographic Types.

1. *The Peneplain.*—The existence of a Late Tertiary peneplain over the greater part of South-eastern Australia has been generally recognized by various writers. In the Wollondilly area several distinct levels can be determined, which have been formed as a result of dissection of this original plain surface, rendering this latter very obscure in many places, and destroying its identity in others. The peneplain may be recognized typically in three districts—the plains around Richlands, the warped southern edge of Jenolan Plateau, and the plains of Lake George and of the Upper Lachlan Basin around Gunning.

Around Richlands, on the Main Divide, the country is very flat and is drained by small, level streams. Burra Lake, a small lagoon at the head of one of the small Abercrombie streams, typifies this district and gives an illustration of the prevailing late mature valleys. Southwards towards Crookwell the level plains with their flat valleys continue, and are hardly broken by the slightly higher basalt hills around McAllister. This country forms the typical peneplain surface and post-dates the basalts, as it is cut partly in eroded basalt, the sides of the valleys in which these flows were originally poured out also being reduced. Viewed from a distance this land gives the level skyline so characteristic of an upraised peneplain.

North of Richlands the slopes rising to Jenolan Plateau are very uniform, and represent the old peneplain at a different stage—where it has been cut into by rapid streams and trenched by juvenile canyons. The district of Gunning and Lake George Plains represents the plain broken and interrupted by faulting. Cullarin Range has risen across the gently-rolling downs, as the lake plains obviously could not have been formed by erosion under the existing conditions of inland drainage. In each case the old surface is very level and has been cut in a variety of rocks, most of which have been greatly folded in past ages. The northern part of the Shoalhaven Plateau, to the north of the Shoalhaven River, is part of the peneplain which has been cut in almost horizontal strata. The more western part of the peneplain surface is interrupted by a few residual peaks of very hard rocks—the monadnocks—but these occur in definite localities, and are not evenly distributed over the area. Northwards, in the Cox Basin and over the Lower Wollondilly, the surface of Hawkesbury Sandstones represents part of the old plain surface which is characterized by

flat valleys and by occasional swamps. The peneplain surface existed before the commencement of the series of Late Tertiary uplifts, which have caused its gradual dissection and destruction.

2. *Valleys of the Plateau.*—The peneplain is dissected by two series of valleys which are of diverse types—mature and juvenile. The mature valleys are found along the courses of the Upper Wollondilly and Cookbundoon and on the Middle Wollondilly, their depth depending on the amount of local warping and faulting of the peneplain. At Yerranderie, also, valleys of this type are found, somewhat deeper and rather less mature. The valleys are more remarkable by reason of the fact that they are not cut in horizontal rocks, but in intensely folded strata. They can be correlated with the valleys of Lithgow and Wallerawang in the Cox Basin to the north, which are cut in horizontal strata of varying hardness, and the presence of these valleys around the periphery of the Central Tableland indicates a common origin, namely, slight uplift of the peneplain followed by erosion at a constant base-level. Since the beginning of the uplift of the peneplain such streams as Mulwaree Creek have been doing a certain amount of erosive work, cutting into the plain surface. The level ridges rising 70 or 80 feet above the modern stream flats would appear to represent the original level of the peneplain here, which is well preserved further to the south, to the east of Lake Bathurst. There has also been a certain amount of modern erosion in the valleys of the Upper Wingecarribee, but the salient features of that section existed before the plateau was raised to its present altitude.

Great canyons have been excavated by the Wollondilly, Abercrombie and Shoalhaven Rivers in the recently-uplifted plateau lands, the streams having accomplished the greatest amount of dissection in the northern part of the area adjacent to the Cox Basin. Canyons of lesser size have been cut in the Cookbundoon fault scarp and through Cullarin Range, these owing their existence to faulting and more local uplift and consequent revival of streams.

3. *Monadnocks.*—On the peneplain surface in the vicinity of Goulburn and in the vicinity of Lake George, there are a number of monadnocks or residual hills which survive from earlier geological periods and cycles of erosion. These are conical in shape and represent parts of synclines. North-south valleys between these residuals mark the presence of anticlines, and on the monadnocks themselves hard, glassy white quartzite is prominent, which not only resists erosion, but buttresses up softer strata and protects them from the attacks of streams. The outcrops of hard quartzite are marked by the presence of small scarps.

Goulburn is situated on one of the most notable of the anticlines along which the Wollondilly flows. The structure of a typical residual is shown in Text-fig. 11, *d*, the general appearance being given by Text-fig. 9, *a*, *b*.

In the northern groups around Goulburn the principal peaks are Towrang (2,845 feet), Governor (2,397 feet), Bullamelita (2,584 feet), Gundary (2,767 feet), and Jerrara (2,530 feet). To the south, on Lake George Plains, Terramungula (3,141 feet), Collector (2,875 feet), and Currowang (2,915 feet) are prominent. On the highlands west of Mulwaree Creek, Bangalore (2,925 feet) and Allianyonyiga (3,327 feet) are the highest points. On the average the Goulburn group of peaks rises to 500 feet above the level of the surrounding plains and valley-floors, whilst those near the Lake are 650 feet higher than the lake plains.

The profile of these conical residuals is quite different from the square outline of the fault blocks, and that alone would serve to distinguish them. They are widely different physiographic forms. The fact that the monadnocks rise to a

constant height above the surrounding plains does not indicate that they are remnants of a former peneplain. Their existence, like that of Mts. Walker and Gangerang in the Cox Basin, can be traced back to the cycles of erosion following the great orogenic movements of the Kanimbla Epoch. The size of the synclinal residuals of hard rocks has decreased gradually since that time until these small peaks only remain now, the greater part of the original masses having long since been eroded. The conical shape of the monadnocks reduces the rate of erosion and lowering to a minimum. Their constant average elevation above the surrounding plains depends on similarity of formation and of past erosion. Where we have peaks removed from the active work of many streams, as is the case with Mt. Allianyonyiga, the height is greater than usual. In this way the similarities in general form and the dissimilarities in altitude may be readily explained.

4. *Basalt as a Physiographic Problem.*—It is not within the scope of this paper to attempt a geological description of the Tertiary basalt flows of the Wollondilly area, but these have a special significance from a physiographic point of view which cannot be overlooked. The base of a basalt flow represents part of the land surface on which the molten lava was originally poured out, and some idea of the past disposition of topography may be gained by correlating these scattered relics of the ancient (Late Tertiary) surface. A classification of areas known to the writer is carried out in the appended table, numbers on which refer to the map (Text-fig. 2).

The various occurrences agree well with the definition of physiographic areas given at the beginning of this paper. In the east, over the Shoalhaven Plateau, the general level of the base of the flows is found at 2,350 feet above sea-level. Towards the west the level of the base varies from 2,700 to 3,100 feet, but the lower sections also represent areas of relative depression on the modern land surface, and a more constant elevation is attained on the Main Divide and towards the Abercrombie River. Thus the Taralga flow, which has a base elevation of 2,700 feet at Taralga, is not found below 3,000 feet on the Main Divide at Richlands in Area No. 2, where the plateau is somewhat higher and more uniformly level. There is, then, a minimum difference of 350 feet in the respective elevations of the bases of the Shoalhaven Plateau and the western basalts, whilst the maximum difference is of the order of 650 feet when we consider the extensive areas along the Main Divide.

The constant base-elevation of the occurrences on the Shoalhaven Plateau (Numbers 7-15) indicates the relative level of parts of the Tertiary land surface, probably the floors of the valleys. In comparing this with other bases we are obviously comparing similar parts of the old land surface, so the actual part considered is not a matter of major importance. We find other parts of the basalt areas immediately to the west of the Shoalhaven Plateau at a somewhat higher elevation (2,500 to 2,700 feet), and still further westwards a constant level is met with at 3,000 feet or thereabouts. Thus the Tertiary surface is differentiated as regards present elevation.

That this was not always the case is indicated by modern topography. The higher levels, both in the case of the Western Wollondilly Block and the levels of the bases of its basalts, end abruptly along a definite north-south line, giving place, in limited sections to intermediate levels, as at Bannaby and Greenwich Park. These in turn give place to the lower levels of the Shoalhaven Plateau. Flexing or faulting between these two major physiographic divisions may be safely inferred

from the break in the Tertiary surface, as represented by the bases of the basalt areas. If anything approaching the present topographic arrangement of a higher

No.	Name.	Locality.	Occurrence.	Altitude of Base.	Thickness.
	GROUP "A"			Feet.	Feet.
1	Taralga	Taralga and district	Extensive flow	2,700	350
2	Macalister ..	Main Divide	Extensive flow	3,150	150
3	Bannister ..	Near Main Divide	Extensive flow	2,725	300
4	The Forest ..	Goulburn district	Flow	2,350	?
5	Mt. Wayo ..	West of the Forest	Capping at 3,052 ft.	—	—
6	Myrtle Creek	South of Taralga	Flow	2,700	100
	GROUP "B"				
7	Robertson ..	Robertson district	Flow	2,350	350
8	Exeter	Sutton Forest district	Flow	2,300	100
9	Wingello ...	South of Wingello	Flow	2,275	50
10	Tillynambulan	Moss Vale district	Residual capping	2,350	275
11	Penang	West of Bowral	Residual capping at 2,603 ft.	—	—
12	Wanganderry	NW. of Mittagong	Flow	2,400	300
13	Cross Roads .	Moss Vale district	Relics of flow	2,350	—
14	Lake Bathurst	On Divide of Shoalhaven	Small flow	2,350	50
15	Bronti	On Divide of Shoalhaven	Small residuals	2,350	—
16	Nerriga	East of Shoalhaven	Small flow	2,100	?
17	Sassafras ...	On Sassafras Range	Local flow	2,500	200
	GROUP "C"				
18	Arthursleigh	Wollondilly Valley	Core? at 2,025 ft.	—	—
19	Bannaby	West of Bannaby	Flow on plain	2,500	?
20	Carrick	5 miles NE. of Carrick	Flow—local	2,200	?
21	Greenwich Pk.	6½ miles N. of Carrick	Flow	2,500	100
22	Greenwich Pk. (East)	East of No. 21	Flow—below plateau	2,275	Relic
23	Cookbundoon	On eastern side of river	Relic of flow	1,940	Relic
	GROUP "D"				
24	Mt. Werong .	Kowmung Divide	Flow?	3,825	150
25	Mt. Shivering	Kowmung Divide	Core? Rises to 3,678 ft.	—	—
	Mt. Shivering (East) ...	Kowmung Divide	Small flow	3,450	Relic
26	Mt. Colong ..	Yerranderie district	Capping — relic of flow	3,125	300
27	Yerranderie Peak	Yerranderie	Dyke—top of peak at 2,780 ft.	—	—
28	Abercrombie .	Southern side of river	Flow	2,975	Relic
29	Bummaroo ..	Northern side of river	Flow	2,950	300
30	Paling Yards	11 miles N. of Abercrombie	Flow—mesas	3,525	Relic
31	Mt. Browne .	13 miles N. of Abercrombie	Flow	3,850	Relic
32	Cat Hill	15 miles N. of Abercrombie	Flow	3,950	Relic

Notes.—Elevations determined mainly by aneroid, and checked against heights of trig. stations and railway stations.

Thickness of basalt is not given in the case of those areas not visited (Nos. 5 and 11); where the thickness is slight the word "Relic" is given; in the case of suspected cores and small surface deposits thickness is not indicated.

General order of accuracy is ± 25′, except in the case of Nos. 30 to 32.

western and a lower eastern area had obtained in the Tertiary period, the present grouping of basalt masses along the present Main Divide would have been quite impossible. The extruded lavas would have flowed to the lower country on either side, especially down the steeper eastern slopes. That such is not the case indicates that the great flows along the Main Divide owe their situation and extent to the existence of a Tertiary valley following that line. The differentiation between the eastern and western sections of the Tertiary levels has taken place since the pouring out of the basalts. In passing, the present maximum thickness of 350 feet attained by the basalts in widely separated parts of the area would indicate some uniformity in the extrusion of the lavas over the whole area.

As regards the areas No. 28 to 32, the change in altitude between the major areas at Bummeroo and Shooter's Hill, a difference between the respective bases of 1,200 feet is especially interesting. This line cuts across the modern valley of the Abercrombie, and was apparently formed along a Tertiary valley. It seems safe to conclude that the warping and uplift of the Jenolan Plateau has tilted these basalt areas, causing them to occur along their present slope.

Two others of the occurrences deserve special mention, namely, Nos. 20 and 22. Both of these are situated below the level of surrounding hills, on opposite sides of the Wollondilly valley. In the case of the former the basalt occupies a depression between granite hills to the east of the river, and possibly represents the line of an old tributary stream. On the other hand, the small basalt area to the east of Greenwich Park station (No. 22) is found on the brow of a hill below the local level of the plateau, and considerably below the more extensive area at Greenwich Park. The relationship between the two is not clear, but there is no modern connection between them.

The past extent of these basalts can be inferred from their present distribution. The presence of a large area at Robertson and of smaller areas in that district at Exeter, Wingello, and Tillynambulan, together with the western extension at Wanganderry at much the same level, points to the fact that a considerable part of this side of the area has been covered by flows of basalt. This also applies to the district along the Main Divide. Intermediate areas were, apparently, not so greatly affected, probably on account of greater elevation, but it must also be remembered that, during the modern stream cycle, this intermediate area has been subject to great erosion, and has been more extensively reduced than those areas to the east and west.

It is not suggested that all the basalts of this area are of approximately the same age. Detailed geological investigation will be necessary before the absolute age of the various occurrences can be determined at all. It is especially probable that the intermediate areas mentioned above will be found to be of different age from the greater areas lying on either side, and these may be specifically associated with the Cookbundoon Fault. A similar state of affairs has been suggested by Jensen (1908) in connection with the basalts associated with the Sassafras Range.

7. *Warps and Faults of the Area.* (Refer to Text-figs. 3 and 12.)

In the Wollondilly Basin, as we have seen from the beginning, a number of maturely-dissected land surfaces are found at varying elevations, and streams are eroding from the lower levels, gradually attacking the more elevated portions. Under these circumstances differentiation of a common level by warping or faulting is suspected, and this idea is confirmed when it is found that the higher levels

end abruptly as steep scarps. At present recognition of these faults or flexures depends entirely on physiographic evidence, the impossibility of these various maturely-dissected surfaces being formed *in situ* under existing conditions, besides the evidence respecting the relationship of scarps and modern stream erosion. The principal warps and faults are:—

a. Kowmung Warp-Nepean Ramp.—The existence of a warped land surface in the Nepean Basin to the south of Sydney is already well established, and the physiography of the Cox and Kowmung areas plainly indicates a continuation of this warp to the west (Craft, 1928). Tilting and uplift towards the south are also indicated in Burragorang Valley, and, viewing the country in that vicinity and to the west of the Upper Nepean River, it is difficult to see how it would be possible for the Nepean Ramp to end sharply along the meridional line of the Nepean and not to be continued westwards without notable faulting and shattering of the rocks, which is certainly not in evidence. The face of the Blue Mountain Monocline extends southwards to Mittagong, and appears to die out towards the Wingecarribee River. This old feature is superimposed on the newer Nepean Ramp and Kowmung Warp.

b. South Jenolan Warp.—The theory has already been advanced that the high plateau around Jenolan Caves is essentially a dome-shaped warp (Craft, 1928; see also Andrews, 1910). This is confirmed by the southern margin of the plateau which extends southwards from Mt. Werong to Wombeyan Caves and Richlands. The tilted plain surface has been dissected by swift southward-flowing streams, but as yet a good deal of the ancient peneplain is preserved. The development of an overthrust fault at Mt. Werong was an incident in the elevation of Jenolan Plateau.

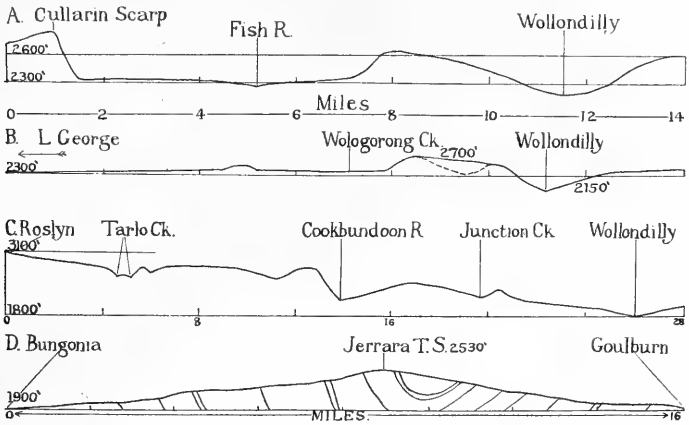
c. The Kanangra-Cookbundoon Fault.—The existence of a fault at Kanangra Walls has already been indicated (Craft, 1928), and the continuation of the scarp of this fault across the southern part of the Jenolan Dome into the Cookbundoon Basin is evidence of the prolongation of this fault, which appears to die out in the vicinity of Goulburn.

On the northern side of the Wollondilly the fault at Mt. Werong and the "step down" at Mt. Shivering represent two different phases of this faulting. In the deeply-dissected country drained by Murruin Creek, the character of the scarp is naturally lost, but it appears further to the south in the vicinity of Wombeyan Caves and Bannaby (Text-fig. 12; Plate xxxix). At the latter place there is a "step up" from the level of the Shoalhaven Plateau at 2,300 feet immediately to the south of Bannaby (the country to the east of the Wollondilly is somewhat higher) to the plains of Bannaby at 2,500 feet, and a steep scarp leads to the higher plateau level at 3,000 feet to the east of Taralga. The height of this latter scarp is partly due to the fact that its crest is marked by an outcrop of resistant quartzite, but the three levels are unmistakable. The 2,400-2,500 feet level extends to the south, and comprises a great deal of the country between the Wollondilly and Cookbundoon Rivers.

South of Bannaby a great escarpment is met with to the west of the Cookbundoon River (Text-fig. 8, *d*). This forms the edge of the Western Wollondilly Block, and is somewhat higher than the country immediately to its west, which consists largely of soft slates that have been eroded fairly readily by the streams, whilst a good deal of the scarp consists of more resistant quartzites. Steep gullies lead down from the higher levels near the Main Divide, but the scarp is, as yet, very little dissected. This straight and prominent section is over 20 miles

long, and continues to the vicinity of Towrang, where it ends rather abruptly. The uniformly high plateau block does not continue to the south of the Wollondilly at Towrang, its place being taken by scattered quartzite monadnocks.

Evidence favouring the theory that this is a fault scarp may be summed up under two headings. Firstly, the scarp forms the edge of a highland block. To the west is a higher plateau; to the east is a lower plateau (Text-fig. 11, *c*). Similar ancient topographic surfaces occur at different levels. Secondly, streams



Text-fig. 11.—*a*, *b*. Sections across the valley of the Upper Wollondilly and Lake George Plains. The wide plain surface to the south of the Wollondilly contrasts sharply with the early mature valley of the Wollondilly. The former surface is part of the old Tertiary peneplain. *c*. The Cookbundoon Fault (Physiographic). A fault exists between similar topographic surfaces. *d*. Section across a typical residual. Contrast the form with that of "*c*".

run from the flat valleys on the higher plateau into steep V-shaped gullies, which are cut into the scarp. The higher levels are thus being attacked by these revived streams, which have based their erosive efforts on the lower land to the east. This indicates recent differentiation in level of the higher block with respect to the lower block. Stages of uplift have produced a series of "steps" in this district.

The valley of Tarlo Creek is closely related to the valley of the Middle Wollondilly, its extra elevation being due to the imperfect grading of a much longer course, and partly, perhaps, to the extra elevation which the Cookbundoon Basin has undergone. Towards Goulburn this complex physiographic fault cannot be definitely recognized, but the southern edge of the Western Wollondilly Block has been considerably warped and downfolded, and also appears to be faulted in places.

The Cookbundoon Fault represents the approximate boundary between the Triassic and Permo-Carboniferous series to the east and the Lower Palaeozoic rocks to the west, although areas of the latter also occur to the east of the fault. This line would appear to represent the revival of an ancient fault line.

d. The Norwood Warp.—The Western Wollondilly Block represents part of the old peneplain surface dissected by mature valleys. Another part of the same peneplain is comprised of the lower country of Mulwaree Creek and Goulburn

and Lake George Plains. On the edge of the higher block a steep scarp leads down to the Lake Plains, whilst gentler slopes lead down to the plains around Goulburn, passing through the hamlet of Norwood. In the former case, forming the northern boundary of the Lake Plains, there is a fine example of a physiographic fault which loses its distinctness towards Goulburn, giving place to a warped surface. The Wollondilly River has cut an early mature valley in the higher land, which contrasts sharply with the level plains further south over which Mulwaree Creek flows (Text-fig. 11, *a*, *b*). From Woodhouslee to Goulburn the slope of the surface is rather gentle, but in the vicinity of Woodhouslee and Mt. Wayo there are small scarps. Thus there is a higher block of land around the Main Divide to the west of the Upper Wollondilly, but further to the east there is a ramp-like surface. Consequently, going westwards from Goulburn, one first traverses the lower surface of the ramp (Text-fig. 7), and then climbs up a steep slope to the Main Divide. This steep slope represents a continuation of the Cullarin Fault.

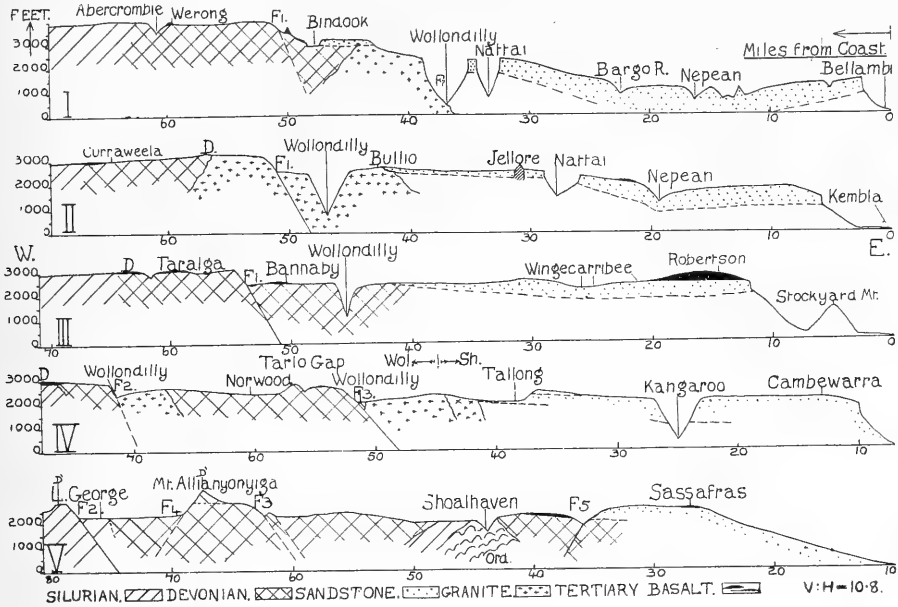
East of Norwood the ramp slope becomes steeper, and passes suddenly into the Cookbundoon Fault to the north of Towrang. This change of physiographic forms going eastwards from the Main Divide is singularly impressive, and the district offers a great contrast to the residual country to the south and east of Goulburn.

e. The Cullarin Fault.—Cullarin Range has been referred to frequently in the foregoing pages and its main features have already been described. The actual fault block was described first by Taylor (1907), who considered the section near Lake George. It has a width of one to two miles, and pursues a general meridional course. North of Cullarin railway station, the steep eastern face of the scarp can be traced for 10 miles, gradually dying out as it comes into the uniformly high country near the head of the Norwood Warp. This northern section of the fault, which has determined part of the course of the Upper Wollondilly, is rather dissected, but the eastern scarp has a newer appearance near Lake George. On the western face the slopes on to the downs of the Upper Lachlan are not so well defined, but the rather dissected scarp can still be recognized readily. The upper courses of Fish and Molonglo Rivers have kept pace in their downcutting with the rising block, and have cut gorges through it, but other streams between these two have been blocked to form Lake George.

As regards age, this fault does not appear to be at all ancient, as it is not greatly dissected, and small streams running through it have not yet graded down their courses very far. It may be stated definitely on field appearance that the northern part of this fault parallel to the Upper Wollondilly is older than the southern part in the vicinity of the Lake.

f. Mulwaree Fault.—Faulting to the west of Mulwaree Creek has been indicated by Andrews (1910), and has already been mentioned as a possibility in this paper. It is only necessary to state here that faulting is indicated by three field facts. Firstly, by the formation of Lake Bathurst; secondly, by the occurrence of high plain relics along the Mulwaree Block; and thirdly, by the formation of Wologorong Lagoon in a local depression and the cutting off of the flow of Wologorong Creek apparently by uplift to the east of the depression. In the latter case, a rather juvenile valley has been incised in the higher plain land by a small creek, the Run of Waters, which has cut back to the edge of Bredalbane Plains. Further south the great fault block of the Gourock Ranges is met with on the western side of the Shoalhaven River and the rift valley in which it flows.

g. Sassafras Fault.—On the eastern side of the Shoalhaven Valley occurs the high fault-block of the Sassafras and Currockbilly Ranges. This was first recognized by Jensen (1908), who wrote (p. 300): "On the eastern side it (i.e., the Sassafras Tableland) falls sharply about 300 feet, and on the western side it falls even more abruptly about 500 to 600 feet. Both slopes present a somewhat faceted appearance, especially on the western side." On the plains of the Shoalhaven Valley at Nerriga there occur isolated hills capped with Upper Marine sandstone dipping to the north-east at a low angle. The base of these series on Sassafras Range is on much the same level, whilst the eastward dip is continued. From this Jensen deduced a fault with a vertical displacement of 500 to 1,000 feet. Allowing for the fact that the base of the Upper Marine Series is not deposited on a perfectly level or plain surface and the approximate nature of the data available, the lower figure may be safely accepted. In passing it is interesting to note



Text-fig. 12.—Sections at intervals across the area. Geology is indicated approximately. Note the differentiation of similar surfaces as one goes from east to west. Physiographic faults are indicated. F_1 = Kanangra-Cookbundoon Fault; F_2 = Cullarin Fault; F_3, F_4 = Faults of Mulwaree Block; F_5 = Sassafras Fault.

that Jensen's paper recognizes a similar method of determining faults by physiographic means to those used in this present paper, namely, the recognition of similar physiographic surfaces separated by scarps, with canyons cut into the higher masses and based on the lower or relatively downthrow lands.

It will be seen that the valley of the Shoalhaven River between the Mulwaree and Gourock Blocks on one hand and the Sassafras and Currockbilly Highlands on the other is a rift valley. This will be treated in a future paper.

h. General Review of the Faulting.—The surface of the plateau in the Wollondilly Basin and contiguous areas is broken and diversified by warps and faults.

In the northern section the edge of the Jenolan Dome and the continuation of the old Blue Mountain Anticline have given more than the general elevation to that part of the plateau. Southwards, the uplift has been produced by normal forces, and the uplifted surface has split along meridional lines giving long faults and narrow fault blocks, one of the faults, Kanangra-Cookbundoon, extending northwards into the Cox Basin.

Going southwards into the Shoalhaven area and the country around Lake George the number of faults increases, giving rise to meridional horsts and rift valleys. Still further to the south the country rises into the Canberra, Kosciusko and Currockbilly Highlands, where the faulting has been more intense and the number of faults is still greater.

In the Wollondilly area blocks of the plateau surface which have been raised above the general level by local uplift are bounded on their northern or southern sides, as the case might be, by east-west warps or faults. Norwood Warp and a warped surface to the north of Sassafras Range are examples. Slight warping has also taken place in the Lake George Basin. On the Pacific side the line of the eastern coast represents a major fault line. Behind this the Nepean Ramp has the form of a syncline.

Streams of the Area.

Most of the notable features of the valleys in which the Wollondilly and its tributaries flow have already been noted, but several points remain to be considered. Taylor and Woolnough (1906) postulated a common line of flow for the Wollondilly and the Upper Shoalhaven, and breaking up of the stream line by reason of the capture of the Lower by the Upper Shoalhaven. I hope to discuss this question in a future paper on the Shoalhaven, and so will not commit myself on the matter at present.

In considering the streams of this area it may be laid down as a fairly definite rule that the stream systems arranged materially as at present existed at the end of the Tertiary period. Since then continuous uplift has allowed streams to become entrenched in their old courses, and subsequent change of course has been the exception rather than the rule. It is necessary to go back into the Tertiary period in order to discuss the origin of the modern drainage.

The streams to the east of the Middle Wollondilly have a typically normal flow over plains, their shape conforming to the "branching tree" pattern. In the western part of the area this is certainly not the case, and two modifying factors suggest themselves—the presence of Tertiary basalt and extensive faulting. To this latter cause the line of the Middle Cookbundoon and Bannaby Creek may be ascribed. Both these streams flow northwards parallel to, a little to the east of, the modern fault scarp. The Upper Wollondilly also shows the influence of faulting. Parallel to the Cookbundoon Fault we have the course of the Middle Wollondilly, situated on the western edge of the Shoalhaven Plateau. The presence of faulting, or a single fault as postulated previously by Taylor (1911), as existing during the Tertiary period, with a downthrow side to the east, added to the prevailing meridional rock strike, would naturally cause the formation of north-south streams, irrespective of original lines of drainage. To this complex cause I assign the meridional tendency of the streams of the Western Wollondilly (Text-fig. 3).

The headwaters of the Abercrombie and Tuglow Rivers, splayed against the Main Divide, also suggest that the original Wollondilly system, to the east, ended sharply against a north-south scarp, and the westward-flowing rivers extended into the present basins of the Tuglow and Middle Wollondilly.

This theory implies that a divide between the eastward and westward flowing streams has been maintained approximately in the position of the present Main Divide over long periods of geological time by the continual elevation of land in this area. Such a state of affairs is indicated by the greatly disproportionate lengths of the two series of streams, even after allowing for a considerable area of recently-lost land to the east of the present coast, and also by the marvellous complexity of the streams to the west of the Main Divide. The courses of these streams have been determined before the beginning of the modern uplifts since the close of the Tertiary period, and must have taken long ages to evolve. Compared to the most complex stream system of such areas, the Cox and Wollondilly Basins are relatively simple.

The effect of volcanic activity and the extrusion of lavas upon stream flow is a very difficult one to handle at all satisfactorily. The line of basalt along the Main Divide appears to indicate ancient stream courses, and the presence of forked and parallel head tributaries of certain eastward-flowing streams such as Taralga, Myrtle and Kerrawary Creeks in all probability indicates the former existence of valleys along these lines, which were filled with basalt, causing the splitting of the original streams, which need not have flowed in their present direction. An assumption that the more or less continuous line of basalts on or near the Main Divide between Gurrunda and Shooter's Hill represents the channel of a major stream is unsatisfactory, because of the greatly differing thickness of the basalt at various places, but more especially on account of the presence of ancient westward-flowing streams immediately to the west. The Wollondilly and Cookbundoon stream lines certainly run perpendicular to the courses of these western streams, but a definite reason for this arrangement—faulting—may be advanced. There is no such apparent reason in the case of an assumed stream following the course of the Main Divide for long distances, and draining to the north or south. In conclusion, therefore, it may be stated that the meridional tendency of the main streams on the western side of the Wollondilly Basin is due to long-continued faulting. This anomalous drainage has not been greatly affected by the pouring out of Late Tertiary lavas. Basalt lines on or near the present Main Divide represent old stream courses which flowed directly into the westward-flowing streams, and did not constitute a single main stream.

With regard to the development of meandering courses by many of the principal streams of the area, especially the Wollondilly, the present floors of many of their valleys are flat, or have been flat and are being dissected by the present cycle of erosion. These would favour the development of meandering courses. In the case of such flat-bottomed valleys as that of the Middle Wollondilly, it is seen that the greatest meanders are developed where these almost straight valleys are widest, and have a minimum depth. Meanders could be formed quite readily under existing conditions, or under conditions that have existed in the immediate past. It is not necessary to suppose that the meandering courses of such streams as the Wollondilly and Cookbundoon have been inherited from the Tertiary peneplain. This also applies to the streams of the Eastern Wollondilly Basin, such as the Wingecarribee. To the west of the Divide the prevailing highly complex streams are certainly more ancient than those further east.

As regards the course of the Wollondilly in the vicinity of Murruin Elbow, I have previously suggested that the Upper Wollondilly and the Kowmung at one time formed a common stream line, which has been subsequently split up by capture, the Lower Wollondilly being the pirate stream. It is also possible that there has been no capture in this section, but the highly abnormal drainage of the Yerranderie district is due to the deflection of the courses of the Wollondilly by the presence of the highly resistant mass of syenite to the south of Yerranderie. The fact that the streams flowing in all directions to the Wollondilly in this section have mature valleys along their upper courses (Text-fig. 5), and the possibility of the meanders of the Upper Wollondilly having been formed in the mature plateau valley since the inception of the modern uplifts would appear to support this idea.

Conclusion.

This study of the plateau regions shows that the uplifted peneplain surface of the Wollondilly Basin has been raised to its present elevation in stages, the oldest uplifts indicated being those in the north (Blue Mountain Anticline). The forces causing the uplift have been normal in character, and have given rise to broad warps and meridional faults. It is probable that the uplifts to the north, already referred to, and those to the south, over the Shoalhaven Basin and the coastal area south of Nowra, began at much the same time, and the more southerly uplift has extended northwards to give such features as the Nepean Ramp and the Kowmung Warp.

Stream change before and during the period of basalt flows is indicated, but the position of the Main Divide would appear to have remained approximately constant over long periods of time. As with the Cox River Basin the geology, as far as known, would appear to indicate that the western side of the area has been an area of relative uplift since Devonian time, whilst the eastern section has been relatively depressed, giving rise to the Triassic and Permo-Carboniferous Systems.

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TAYLOR, T. G., 1903.—The Geology of Mittagong. *Proc. Roy. Soc. N.S.W.*, xxxvii.

————, 1907.—The Lake George Senkungsfeld, a study of the evolution of Lakes George and Bathurst, N.S.W. PROC. LINN. SOC. N.S.W., xxxii, Part 2.

————, 1910.—The Physiography of the proposed Federal Territory at Canberra. Bulletin 6, *Commonwealth Meteorological Bureau.*

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WOOLNOUGH, W. G., and TAYLOR, T. G., 1906.—A Striking Example of River Capture in the Coastal District of N.S.W. PROC. LINN. SOC. N.S.W., xxx, Part 3.

EXPLANATION OF PLATE XXXIX.

Block Diagram of the Wollondilly Basin. A low plateau is crossed by residual ridges and faults. On the northern side it gives place to higher and more broken land. Streams are gradually cutting deep canyons in the level surfaces of an uplifted peneplain, and trenching the older and more mature valleys.

NOTES ON AUSTRALIAN DIPTERA, No. xviii.

By J. R. Malloch.
(*Communicated by I. M. Mackerras.*)

[Read 28th November, 1928.]

A Preliminary Catalogue of Australian Tachinidae.

An essential prerequisite to work upon any group is a catalogue of the already described species belonging thereto. Realizing this and being well aware of the difficulties attendant upon obtaining access to many of the older works in which the Australian Tachinidae have been described, I assume that the preliminary catalogue of species presented herein will prove of value to anyone who intends to undertake any work upon the group, be it either merely the identification of a few species or a complete revision of the family.

I have had the manuscript for some time and two or three years ago promised the late Dr. E. W. Ferguson that I would publish it in this series of papers, but until now have not had the time to go over the records again. I have exercised some care in my endeavour to make the list complete, but do not make the claim that I have entirely succeeded in this, and I have not attempted to include all of the references to the species in the papers quoted, only the principal descriptive matter being included as a rule, though I have tried to include all new generic references.

It will be seen that there is quite an array of species included, but it is not to be assumed that all names standing in this list as apparently valid species are in that category. I have not attempted to synonymize species, except where previous workers have already done so, but I know many of the included names will have to be sunk as synonyms of previously described forms appearing in the catalogue. The work of weeding out such synonyms can only be done by someone who will undertake a comprehensive study of the family, and definite identifications will usually depend upon an examination of the type specimens of the species.

Alphabetical Catalogue of genera and species.

I. Genus *Acephana* Townsend.

1. *rubrifrons* Macquart, *Dipt. Exot.*, Suppl. ii, 1847, 85 (*Masicera*); Townsend, *Canad. Ent.*, 48, 1916, 153. Tasmania. Genus not seen by describer.

II. Genus *Actia* Robineau-Desvoidy.

2. *eucosmae* Bezzi, *Ann. Mag. Nat. Hist.*, ser. 9, xvii, 1926, 239. Queensland.
3. *fergusoni* Bezzi, Proc. Linn. Soc. N.S.W., 48, pt. 4, 1923, 657. (Subgenus *Schizotachina*) = *Schizactiana* Curran. N.S.W.
4. *valida* Curran, *Ent. Mitt.*, 16, No. 5, 1927, 336 (Subgenus *Schizactiana*). Queensland.

III. Genus *Alophora* Robineau-Desvoidy.

5. *auriventris* Curran, *Bull. Ent. Research*, xviii, 1927, 165. Queensland.

IV. Genus *Amenia* Robineau-Desvoidy.

6. *dubitalis* Malloch, Proc. Linn. Soc. N.S.W., 52, pt. 3, 1927, 343. N.S.W.
7. *imperialis* Robineau-Desvoidy, *Essai sur Myod.*, 1830, 443-4. Australia.

8. *leonina* (Fabricius), *Syst. Ent.*, 1775, 776; *Ent. Syst.*, iv, 1794, 318; *Syst. Antl.*, 1805, 290 (*Musca*); Macquart, *Dipt. Exot.*, Suppl. iv (2), 1851, 195 (*Ptylostylum albomaculatum*). Australia.

9. *parva* Schiner, *Novara Reise*, Diptera, 1868, 316. N.S.W.

9*a*. *stictica* Brauer and von Bergenstamm, *Musc. Schiz.*, ii, 1891, 114 (418). Australia. *Nomen nudum.*

10. *varia* Walker, *Ins. Saund.*, Dipt., 1852, 342 (*Musca*). Genus doubtful. S. Aust.

V. Genus *Amphibolia* Macquart.

11. *speciosa* Erichson, *Arch. f. Naturges.*, 1842, vol. 2, p. 273, 254. Australia.

12. *valentina* Macquart, *Dipt. Exot.*, ii, pt. 3, 1843, 279-80; Guérin, *Rev. Zool.*, 6, 1843, 272, as *fulvipes*; Townsend, *Proc. U.S. Nat. Mus.*, 49, 1916, 618 (*Euamphibolia*, n. gen.). Australia.

VI. Genus *Amplipila* Curran.

13. *versicolor* Curran, *Ent. Mitt.*, 16, No. 6, 1927, 446. Queensland.

VII. Genus *Anagonia* Brauer and von Bergenstamm.

14. *spylosioides* Brauer and von Bergenstamm, *Musc. Schiz.*, ii, 1891, 37. Tasmania.

VIII. Genus *Anamastax* Brauer and von Bergenstamm.

15. *goniaeformis* Macquart, *Dipt. Exot.*, Suppl. i, 1845, 157 (*Blepharipeza*); Brauer and von Bergenstamm, *Musc. Schiz.*, ii, 1891, 45. Tasmania.

IX. Genus *Aprotheca* Macquart.

16. *rufipes* Macquart, *Dipt. Exot.*, Suppl. iv (2), 1851, 149. Not seen by Brauer and von Bergenstamm, but referred by them to the *Micropalpus* group. Tasmania.

X. Genus *Apsophana* Townsend.

17. *rufifacies* Macquart, *Dipt. Exot.*, Suppl. ii, 1847, 87 (*Masicera*); Townsend, *Canad. Ent.*, 48, 1916, 153. Tasmania. Genus not seen by describer.

XI. Genus *Austrophryno* Townsend.

18. *densa* Walker, *Ins. Saund.*, Diptera, 1852, 288 (*Tachina*); Townsend, *Canad. Ent.*, 48, 1916, 160. N.S.W. Genus not seen by describer.

XII. Genus *Ballardia* Curran.

19. *pallipes* Curran, *Bull. Ent. Research*, xviii, 1927, 166. Queensland.

XIII. Genus *Carcelia* Robineau-Desvoidy.

20. *tasmanica* Robineau-Desvoidy, *Hist. Nat. Dipt.*, 1, 1863, 240. Says that it was labelled *Phorocera scutellaris* Macquart by Macquart. Tasmania.

XIV. Genus *Catharosia* Rondani.

21. *varicolor* Curran, *Bull. Ent. Research*, xviii, 1927, 165. Queensland.

XV. Genus *Chaetophthalmus* Brauer and von Bergenstamm.

22. *bicolor* Macquart, *Dipt. Exot.*, Suppl. iii, 1847, 204 (*Micropalpus*); Brauer and von Bergenstamm, *Musc. Schiz.*, ii, 1891, 79 (383). Australia.

23. *brevigaster* Macquart, *Dipt. Exot.*, Suppl. i, 1845, 149 (*Micropalpus*); Brauer and von Bergenstamm, *Musc. Schiz.*, ii, 1891, 79 (383); Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 156 (*Nemoraea*); Macquart, id., Suppl. v, 1855, 131. ? (*Ochromyia nudistylum*). Tasmania, Australia.

24. *ruficeps* Macquart, *Dipt. Exot.*, Suppl. ii, 1847, 89 (*Myobia*); Brauer, *Sitz. Akad. Wiss.*, cvi, 1897, 335. Tasmania.

25. *similis* Walker, *Ins. Saund.*, Diptera, p. 266 (*Tachina*); Austen, *Ann. Mag. Nat. Hist.*, ser. 7, xix, 1907, 333. N.S.W.

26. *tenuisetosa* Macquart, *Dipt. Exot.*, Suppl. ii, 1891, 90 (*Myobia*); Brauer, *Sitz. Akad. Wiss.*, cvi, 1897, 334. Tasmania, Australia.

XVI. Genus *Chetogaster* Macquart.

27. *violacea* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, p. 198. Not seen by Brauer. Australia.

XVII. Genus *Chlorogaster* Macquart.

28. *rufipes* Schiner, *Novara Reise*, Diptera, 1868, 323; Brauer and von Bergenstamm, *Musc. Schiz.*, i, 1889, 29 (97); ii, 1891, 37 (341); iii, 1893, 35 (123), *C. rufipes* Macquart. New Zealand (Schiner), Australia (B. & B.).

29. *tasmanensis* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 157. Tasmania.

XVIII. Genus *Chlorodexia* Townsend.

30. *froggattii* Townsend, *Canad. Ent.*, 48, 1916, 154. N.S.W.

XIX. Genus *Chlorotachina* Townsend.

31. *flaviceps* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 158 (*Chrysosoma*); Townsend, *Proc. Biol. Soc. Wash.*, 28, 1921, 21. Australia.

XX. Genus *Chrysopasta* Brauer and von Bergenstamm.

32. *versicolor* Brauer and von Bergenstamm, *Musc. Schiz.*, i, 1891, 171. Australia.

XXI. Genus *Crypsina* Brauer and von Bergenstamm.

33. *prima* Brauer and von Bergenstamm, *Musc. Schiz.*, i, 1889, 29 (97). Australia. Doubtfully referred to *Platytania*, *l.c.*, iii, 1893, 34 (122).

XXII. Genus *Degeeria* Meigen.

34. *australis* Macquart, *Dipt. Exot.*, Suppl. ii, 1847, 84. Possibly a *Phorocera*. Tasmania.

35. *lateralis* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 176. Oceania? Genus doubtful.

XXIII. Genus *Demoticus* Macquart.

36. *certima* Curran, *Ent. Mitt.*, 16, No. 5, 1927, 351. Queensland.

XXIV. Genus *Dexia* Meigen.

37. *appendiculata* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 202. Tasmania. Genus doubtful.

37*a*. *hyria* Walker, *List Dipt. Brit. Mus.*, pt. iv, 1849, 843. Adelaide. Genus doubtful.

38. *notata* Walker, *Insec. Saund.*, Diptera, 1852, 309. N.S.W. Genus doubtful.

39. *tessellata* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 202. Says it may be female of next species.

40. *testaceicornis* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 201. Genus doubtful in both cases.

XXV. Genus *Doddiana* Curran.

41. *pallens* Curran, *Ent. Mitt.*, 16, No. 5, 1927, 353. Queensland.

XXVI. Genus *Erythronychia* Brauer and von Bergenstamm.

42. *australensis* Schiner, *Novara Reise*, Diptera, 1868, 325 (*Demoticus*); Brauer and von Bergenstamm, *Musc. Schiz.*, ii, 1891, 56 (360). New Zealand (Schiner and B. & B.), Australia? (B. & B.).

Genus *Euamphibolia* Townsend.

Proc. U.S. National Museum, 49, 1916, 618. Synonym of *Amphibolia*.

XXVII. Genus *Euphasia* Townsend.

43. *picta* Brauer and von Bergenstamm, *Musc. Schiz.*, iii, p. 12 (100), 122 (210) (*Neophasia*); Townsend, *Smiths. Misc. Coll.*, 51, No. 1803, 1908, p. 76. Western Australia.

XXVIII. Genus *Eurigaster* Macquart.

44. *lateralis* Macquart, *Dipt. Exot.*, ii, pt. 3, 1843. Australia. Genus doubtful.

XXIX. Genus *Eurygastropsis* Townsend.

45. *tasmaniae* Walker, *Trans. Ent. Soc. Lond.*, n.s. iv, 1857, 197 (*Eurigaster*); Austen, *Ann. Mag. Nat. Hist.*, ser. 7, xix, 1907, 331, gen. n.; Townsend, *Canad. Ent.*, 48, 1916, 158. Tasmania. This genus was erected by Townsend without access to specimens and merely from printed notes by Austen.

XXX. Genus *Eustacomyia* Malloch.

46. *breviseta* Malloch, Proc. Linn. Soc. N.S.W., 52, pt. 3, 1927, 337. N.S.W.

XXXI. Genus *Exechopalpus* Macquart.

47. *rufipalpus* Macquart, *Dipt. Exot.*, Suppl. ii, 1847, 92; Brauer, *Sitz. Akad. Wiss.*, cvii, 1898, 510, cites the genus as near *Genea* and *spathipalpus* in the *Pyrrhosia* group. Australia.

XXXII. Genus *Exorista* Meigen.

48. *auriceps* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 158. Oceania?

49. *dispar* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 159. Eastern Australia.

XXXIII. Genus *Formosia* Guérin.

50. *atribasis* Walker, *Proc. Linn. Soc.*, 5, 1860, 288. Australia.
syn. *pretiosa* Snell. v. Vollen., *Verslag. Med. K. Akad. Witensch.*, 15, 1863, 15.
syn. *smaragdifera* Bigot, *Ann. Soc. ent. France*, 1874, 462.

51. *callipygus* Gerstacker, *Stett. Ent. Zeit.*, 21, 1860, 178. Australia.
syn. *saturatissima* Walker, *Proc. Linn. Soc.*, 5, 1860, 287.

52. *chrysame* Walker, *List Dipt. Brit. Mus.*, pt. 4, 1849, 866. Australia. Genus doubtful.

53. *flavipennis* Macquart, *Dipt. Exot.*, Suppl. ii, 1843, 50. Australia.

54. *hypsa* Walker, *List Dipt. Brit. Mus.*, pt. 4, 1849, 866, locality unknown; Bigot, *Ann. Soc. ent. France*, ser. 5, iv, 1874, 458 (*Formosia*). Sydney.

55. *mirabilis* Guérin, *Voy. Coquille*, Zool. ii, (2) (1), 1832, 297 (*Musca*); Guérin, *Icon. Règ. anim.*, Ins. iii, 1843, 551, Pl. 102, fig. 5. Australia.
syn. *plumicornis* Macquart, *Dipt. Exot.*, ii, pt. 3, 1843, 239 (*Rutilia*).
syn. *fervens* Walker, *Proc. Linn. Soc.*, 5, 1860, 288. New Guinea.

56. *moneta* Gerstacker, *Stett. Ent. Zeit.*, 21, 1863, 200. Australia.

XXXIV. Genus *Froggattimyia* Townsend.

57. *hirta* Townsend, *Canad. Ent.*, 48, 1916, 155. N.S.W.

XXXV. Genus *Gerotachina* Townsend.

58. *obtusa* Walker, *Ins. Saund.*, Diptera, 1852, 274 (*Tachina*); Austen, *Ann. Mag. Nat. Hist.*, ser. 7, xix, 1907, 330 (*Microtropeza*?). Townsend, *Canad. Ent.*, 48, 1916, 152. N.S.W.
syn. *stolida* Walker, *Trans. Ent. Soc. Lond.*, n.s. 4, 1857, 195 (*Echinomyia*).

XXXVI. Genus *Gonia* Meigen.

59. *milias* Walker, *List Dipt. Brit. Mus.*, pt. iv, 1849, 799. Probably not this genus. Australia.

XXXVII. Genus *Gymnosoma* Meigen.

60. *rotundata* Meigen. Macquart, *Dipt. Exot.*, Suppl. ii, 1847, 97, says an individual from Tasmania is exactly like the European species, but there is reason to suspect this identification.

XXXVIII. Genus *Heterometopia* Macquart.

61. *analis* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1847, 182. Tasmania.

62. *argentea* Macquart, *Dipt. Exot.*, Suppl. i, 1845, 170; Hardy, *Rec. Austr. Mus.*, xiii, No. 5, 1922, 198. Redescription. Tasmania; N.S.W.

63. *nitida* Macquart, *Dipt. Exot.*, Suppl. i, 1845, 190 (*Omalogaster*); Brauer, *Sitz. Akad. Wiss.*, cviii, 1899, 505, places it as probably a *Heterometopia*. Tasmania (Mcq.), N.S.W. (Brauer).

64. *rufipalpis* Macquart, *Dipt. Exot.*, Suppl. ii, 1847, 90; Brauer and von Bergenstamm, *Musc. Schiz.*, i, 1889, 67 (135); ii, 1891, 69 (373). Australia.

XXXIX. Genus *Hyalomyia* Robineau-Desvoidy.

65. *rufiventris* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 188. Possibly not this genus. Tasmania.

XL. Genus *Hyleorus* Aldrich.

66. *furcatus* Aldrich, *Trans. Amer. Ent. Soc.*, lii, 1926, 17. Queensland.

XLI. Genus *Masicera* Macquart.

67. *auriceps* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 168. Tasmania.

68. *argenticeps*, Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 166. Oceania?

69. *caesiofasciata* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 165. East Coast of Australia.

70. *consanguinea* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 167. Oceania?

71. *similis* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 168. Tasmania.

72. *simplex* Macquart, *Dipt. Exot.*, Suppl. ii, 1847, 87; Brauer, *Sitz. Akad. Wiss.*, cvi, 1897, 337, says this appears the same as *M. oblonga* Mcq., but it hardly appears probable to me that it is so.

73. *varipes* Macquart, *Dipt. Exot.*, Suppl. i, 1845, 163. Tasmania.

XLII. Genus *Mesembrinomintho* Townsend.

74. *compressa* Townsend, *Canad. Ent.*, 48, 1916, 159. A dexiine with long haired arista, and strong bristles on disc and apex of each tergite from 2 to 4 inclusive. Hamilton, Queensland.

XLIII. Genus *Microceromasia* Villeneuve.

75. *sphenophori* Villeneuve, *Wien. Ent. Zeit.*, 30, 1911, 82. A widespread Old World species which has been introduced into Australia. Although the species appears as *Ceromasia sphenophori* in the paper in which it was originally described, a new genus is erected for its reception in the paragraph immediately above the species description.

XLIV. Genus *Micropalpus* Macquart.

76. *concavicornis* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 146. Probably not this genus. East Coast of Australia.

77. *pilifacies* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 146. Probably not this genus. East Coast of Australia.

78. *vittatus* Macquart, *Dipt. Exot.*, Suppl. i, 1845, 150. Possibly a *Chaetophthalmus* (B. & B.). Tasmania.

XLV. Genus *Microtropesa* Macquart.

79. *sinuata* Donovan, *Epit. N.H. Ins. New Holland*, etc., Hym.-Dipt., 1798 (*Musca*); Wiedemann, *Auss. Zweifl. Ins.*, ii, 1830, 384 (*Musca*); Macquart, *Dipt. Exot.*, Suppl. i, 1845, 186. Australia.

syn. *nigricornis* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 199.

XLVI. Genus *Myiotrixa* Brauer and von Bergenstamm.

80. *prosopina* Brauer and von Bergenstamm, *Musc. Schiz.*, iii, 1893, 8 (96). Western Australia.

XLVII. Genus *Nemoraea* Robineau-Desvoidy.

81. *brevisetosa* Macquart, *Dipt. Exot.*, Suppl. i, 1845, 154. Possibly not this genus. Tasmania.

82. *erythropus* Walker, *Trans. Ent. Soc. Lond.*, n.s. v, 1860, 298. Possibly not this genus. Tasmania.

83. *nitidiventris* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 155. Possibly not this genus. East Coast of Australia.

XLVIII. Genus *Ochromyia* Macquart.

flavipennis Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 218, *nec* Macquart, *l.c.*, ii, pt. 3, 1843, 291. Tasmania. This name has no standing, being a homonym of the second one listed above which is from Brazil.

84. *hyalipennis* Macquart, *Hist. Nat. Dipt.*, ii, 1834, 250. Genus doubtful; reported as a *Palpostoma*. Tasm.

85. *nigricornis* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 218. East Coast of Australia.

XLIX. Genus *Ocyptera* Latreille.

86. *diversa* Walker, *Ins. Saund.*, Diptera, 1852, 262. Generic location doubtful. Tasmania.

L. Genus *Ocypteropsis* Townsend.

87. *bicolor* Bigot, *Bull. Soc. ent. France*, 1885, p. lv (*Glossidionophora*). Australia. I do not know what the status of *Glossidionophora* is.

88. *bimacula* Walker, *List Dipt. Brit. Mus.*, pt. iv, 1849, 694 (*Ocyptera*). Tasmania.

89. *flavifrons* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 187 (*Ocyptera*); Townsend, *Proc. U.S. Nat. Mus.*, xlix, 1916, 630. Australia, Tasmania.

90. *tristis* Bigot, *Ann. Soc. ent. France*, ser. 5, viii, 1878, 45 (*Ocyptera*); Brauer, *Sitz. Akad. Wiss.*, cvii, 1898, 493 (*Ocyptera*). Australia.

LI. Genus *Omalogaster* Macquart.

91. *brevipalpis* Macquart, *Dipt. Exot.*, Suppl. i, 1845, 189. Genus doubtful. Tasmania.

92. *limbineuris* Macquart, *Dipt. Exot.*, Suppl. i, 1845, 189. Genus doubtful. Tasmania.

LII. Genus *Palia* Curran.

93. *aureocauda* Curran, *Ent. Mitt.*, 16, No. 6, 1927, 444. Queensland.

LIII. Genus *Paliana* Curran.

94. *basalis* Curran, *Ent. Mitt.*, 16, No. 6, 1927, 445. Queensland.

95. *intensa* Curran, *Ent. Mitt.*, 16, No. 6, 1927, 446. Queensland.

LIV. Genus *Palpostoma* Robineau-Desvoidy.

96. *apicalis* Malloch, Proc. Linn. Soc. N.S.W., 52, pt. 3, 1927, 339. N.S.W.

97. *desvoidyi* Aldrich, *Proc. U.S. Nat. Mus.*, 62, art. 11, 1922, 5. N. Queensland.

98. *flava* Coquillett, Proc. Linn. Soc. N.S.W., 1900, 390 (*Myiophasia*); Aldrich, *Proc. U.S. Nat. Mus.*, 62, art. 11, 1922, 4; Townsend, *Proc. Biol. Soc. Wash.*, 28, 1915, 22 (*Opsophasiops*); Townsend, *Ins. Ins. Menst.*, 1915, 111 (as *P. testacea* R.-D.). Tasmania.

99. *testacea* Robineau-Desvoidy, *Essai Myod.*, 1830, 429. Australia.

LV. Genus *Parabrachelia* Townsend.

100. *rufipes* Macquart, *Dipt. Exot.*, Suppl. ii, 1847, 86 (*Masicera*); Townsend, *Canad. Ent.*, 48, 1916, 159. Tasmania. Genus erected without access to specimens and from descriptions only. Brauer's notes (*Sitz. Akad. Wiss.*, cvi, 1897, 339) form the basis of Townsend's generic name in this case and in the case of other genera erected in the paper cited in this paragraph.

LVI. Genus *Paraeupogona* Townsend.

101. *oblonga* Macquart, *Dipt. Exot.*, Suppl. ii, 1847, 86 (*Masicera*); Brauer, *Sitz. Akad. Wiss.*, cvi, 1897, 338 (gen. n.); Townsend, *Canad. Ent.*, 48, 1916, 157. Tasmania. See note under previous species.

LVII. Genus *Paramenia* Brauer and von Bergenstamm.

102. *macularis* Walker, *Proc. Linn. Soc.*, iii, 1857, 104 (*Musca*). Aru Is.
syn. *semiauriceps* Brauer and von Bergenstamm, *Musc. Schiz.*, i, 1889, 83 (151). Australia.

LVIII. Genus *Phorocera* Robineau-Desvoidy.

103. *acutangulata* Macquart, *Dipt. Exot.*, Suppl. iii, 1847, 208; Brauer, *Sitz. Akad. Wiss*, cvi, 1897, 347 (*Setigena*). Genus doubtful. Australia.

104. *biserialis* Macquart, *Dipt. Exot.*, Suppl. ii, 1847, 89; Brauer, *Sitz. Akad. Wiss.*, cvi, 1897, 347. Genus doubtful. Tasmania. (Used by Townsend as the genotype of *Austrophorocera*, gen. n., *Canad. Ent.*, 48, 1916, 157.

105. *cilipes* Macquart, *Dipt. Exot.*, Suppl. ii, 1847, 88; Brauer, *Sitz. Akad. Wiss.*, cvi, 1897, 344. There were two specimens in the Macquart collection, a female with label "Australia" and a male without a label. It is evident that the female, which Brauer refers to the subgenus *Ctenophorocera*, is the type, the male belonging to a different species, and possibly a distinct genus.

106. *flavipalpis* Macquart, *Dipt. Exot.*, Suppl. v, 1855, 122; Brauer, *Sitz. Akad. Wiss.*, cvi, 1897, 345. Same group as *cilipes*. N.S.W.

107. *graciliseta* Macquart, *Dipt. Exot.*, Suppl. ii, 1847, 88; Brauer, *Sitz. Akad. Wiss.*, cvi, 1897, 347 (*Setigena*). Tasmania.

108. *grandis* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 171. East Coast of Australia.

109. *hyalipennis* Macquart, *Dipt. Exot.*, Suppl. v, 1855, 122. Genus doubtful. Adelaide.

110. *lateralis* Macquart, *Dipt. Exot.*, Suppl. i, 1845, 165. Tasmania.

111. *maculata* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 173. East Coast Australia.

112. *mucrocornis* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 174. Tasmania.

113. *ornata* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 172. Tasmania.

114. *scutellata* Macquart, *Dipt. Exot.*, Suppl. i, 1845, 165. Tasmania.

115. *subpubescens* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 172. Tasmania.

116. *tessellata* Macquart, *Dipt. Exot.*, Suppl. i, 1845, 165; Brauer, *Sitz. Akad. Wiss.*, cvi, 1897, 345 (*Setigena*). Tasmania.

LIX. Genus *Phryno* Robineau-Desvoidy.

117. *calliphon* Walker, *List Dipt. Brit. Mus.*, pt. iv, 1849, 777 (*Tachina*); Austen, *Ann. Mag. Nat. Hist.*, ser. 7, xix, 1907, 338, says the type bears the label "Picton", but region of origin is doubtful. Possibly not Australian.

118. *diversicolor* Macquart, *Dipt. Exot.*, Suppl. ii, 1847, 83 (*Exorista*); Brauer, *Sitz. Akad. Wiss.*, cvi, 1897, 342, says it belongs with *Exorista vetula* Meigen, which is a *Phryno*. Tasmania.

LX. Genus *Platytainia* Macquart.

119. *maculata* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 179; Brauer and von Bergenstamm, *Musc. Schiz.*, ii, 1891, 99 (403); iii, 1893, 147 (235); doubtfully identified with *Crypsina* B. & B., but not seen by them. Tasmania.

LXI. Genus *Platytropesa* Macquart.

120. *rubriceps* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 197. Oceania?

LXII. Genus *Polychaeta* Macquart.

121. *nigra* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 154; Brauer and von Bergenstamm, *Musc. Schiz.*, iii, 1893, 148 (236), doubtfully refer it to *Tritaxys*, but not seen by them. Tasmania.

LXIII. Genus *Prodiaphania* Townsend (= *Diaphania* Macquart preocc.).

grisea Brauer and von Bergenstamm, *Musc. Schiz.*, ii, 1891, 113 (417). *Nomen nudum*. Australia.

122. *testacea* Macquart, *Dipt. Exot.*, ii, pt. 3, 1843, 278; Suppl. i, 1845, 176, refers to *Rutilia*; Suppl. ii, 94 (*Rutilia*); Suppl. iv, pt. 2, 1851, 193 (*Diaphania*), restores the genus. Australia, Tasmania.

syn. *echinomides* Bigot, *Ann. Soc. ent. France*, ser. 5, iv, 1874, 466 (*Formosia*).

LXIV. Genus *Prosena* St. Fargeau and Serville.

123. *argentata* Curran, *Ent. Mitt.*, 16, No. 5, 1927, 348. N. Queensland.

124. *bella* Curran, *Ent. Mitt.*, 16, No. 5, 1927, 349. N. Queensland.

125. *conica* Guérin, *Voy. Coquille*, Zool., ii (2) (1), 1830?, 298. Genus uncertain. N.S.W.

126. *dispar* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 203. Genus uncertain. Tasmania.

127. *doddi* Curran, *Ent. Mitt.*, 16, No. 5, 1927, 347. Queensland.

128. *dorsalis* Macquart, *Dipt. Exot.*, Suppl. ii, 1847, 97; Brauer, *Sitz. Akad. Wiss.*, cviii, 1899, 507, confirms generic reference. Tasmania.

longipes Brauer and von Bergenstamm, *Musc. Schiz.*, ii, 1891, 113 (417), 128 (432). *Nomen nudum.*

129. *macropus* Thomson, *Eugen. Resa*, Diptera, 1868, 531. N.S.W.

130. *nigripes* Curran, *Ent. Mitt.*, 16, No. 5, 1927, 347. N. Queensland.

131. *rufiventris* Macquart, *Dipt. Exot.*, Suppl. ii, 1847, 96; Brauer, *Sitz. Akad. Wiss.*, cviii, 1899, 507, confirms generic reference. Tasmania.

132. *vittata* Guérin, *Voy. Coquille* Zool. ii (2) (1), 1830?, 299; Macquart, *Dipt. Exot.*, ii, pt. 3, 1843, 249, suggests that this is the female of *conica* Guérin on the basis of specimens sent by the describer. N.S.W.

LXV. Genus *Protomeigenia* Townsend.

133. *aurea* Townsend, *Canad. Ent.*, 48, 1916, 156. N.S.W.

Genus *Pseudoformosia* Brauer and von Bergenstamm.

Musc. Schiz., ii, 1889, 126, syn. of *Formosia* Guérin.

LXVI. Genus *Rhinomyiobia* Brauer and von Bergenstamm.

134. *australis* Brauer and von Bergenstamm, *Musc. Schiz.*, iii, 1893, 52 (140). Australia.

135. *flavipes* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 160. Oceania?

136. *marginata* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 161. Australia.

137. *melas* Bigot, *Ann. Soc. ent. France*, ser. 6, vii, 1887, 256. Tasmania.

138. *rufomaculata* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 160. Tasmania.

139. *translucens* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 162. Tasmania. (Genera doubtful in all cases.)

LXVII. Genus *Rhynchiodexia* Bigot.

140. *brevipalpis* Rondani, *Arch. Zool. Modena*, iii, 22 (*Dexia*). Generic assignment made on the basis of statement "Similis *D. rubricarinatae* Mcq.", but it may not be congeneric. Australia.

141. *longipes* Macquart, *Dipt. Exot.*, Suppl. i, 1845, 187 (*Dexia*); Brauer, *Sitz. Akad. Wiss.*, cviii, 1899, 507; Walker, *List Dipt. Brit. Mus.*, pt. iv, 1849, 851 (*Dexia longipes* var.?). Tasmania; Australia (Walker).

142. *punctipennis* Macquart, *Dipt. Exot.*, Suppl. i, 1845, 187 (*Dexia*); Brauer, *Sitz. Akad. Wiss.*, cviii, 1899, 507. Australia.

143. *rubricarinata* Macquart, *Dipt. Exot.*, Suppl. i, 1845, 187 (*Dexia*); Brauer, *Sitz. Akad. Wiss.*, cviii, 1899, 507. Tasmania; Australia (Brauer).

LXVIII. Genus *Rutilia* Robineau-Desvoidy.

144. *aditha* Walker, *List Dipt. Brit. Mus.*, pt. iv, 1849, 854 (*Rutilia* group, *Dexia*). Swan River.

145. *albopicta* Thomson, *Eugen. Resa*, Dipt., 1868, 529. N.S.W.

146. *analoga* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 191; Schiner, *Novara Reise*, Diptera, 1868, 318. Tasmania; Sydney, N.S.W. (Schiner).

147. *argentifera* Bigot, *Ann. Soc. ent. France*, ser. 5, iv, 1874, 464 (*Formosia*); Brauer, *Sitz. Akad. Wiss.*, cviii, 1899, 512; Engel, *Zool. Jahrb.*, 50, 1925, 365. N.S.W.; Queensland (Engel).

148. *assimilis* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 192; Brauer and von Bergenstamm, *Musc. Schiz.*, ii, 1891, 85 (389); iii, 1893, 88 (176) (*Paramphibolia*). East Coast of Australia; Tasmania. I have not seen this species and the validity of the genus *Paramphibolia* is doubtful.

149. *barcha* Walker, *List Dipt. Brit. Mus.*, pt. iv, 1849, 857 (*Rutilia* group, *Dexia*). Australia.

150. *castanipes* Bigot, *Ann. Soc. ent. France*, ser. 5, x, 1880, 87; Bigot, *l.c.*, 1880, 88 (*castanipous*); Brauer, *Sitz. Akad. Wiss.*, cviii, 1899, 512. Australia.

151. *decorum* Guérin, *Rev. Zool.*, vi, 1843, 266. Australia.

syn. *dorsomaculatum* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 196 (*Graphostylum*). Tasmania.

152. *desvoidyi* Guérin, *Rev. Zool.*, 6, 1843, 269; Engel, *Zool. Jahrb.*, 50, 1925, 371. Australia.

153. *durvillei* Robineau-Desvoidy, *Essai Myod.*, 1830, 321; Macquart, *Dipt. Exot.*, Suppl. i, 1845, 175, says this is only a variety of *desvoidyi* Guérin. Australia.

154. *erichsoni* Brauer and von Bergenstamm, *Musc. Schiz.*, ii, 1891, 418. Swan River; Australia.

155. *ethoda* Walker, *List Dipt. Brit. Mus.*, pt. iv, 1849, 856 (*Rutilia* group, *Dexia*). Swan River. Not since recognized.

156. *flavipes* Brauer and von Bergenstamm, *Musc. Schiz.*, i, 1889, 58 (126); ii, 1891, 125 (429). Australia. Brauer (*Sitz. Akad. Wiss.*, cviii) in 1899 expressed the opinion that this is a synonym of *variegata* Macquart, but there is some doubt as to this.

157. *formosa* Robineau-Desvoidy, *Essai Myod.*, 1830, 320; Engel, *Zool. Jahrb.*, 50, 1925, 361, redescription. Australia.

frontosa Brauer and von Bergenstamm, *Musc. Schiz.*, ii, 1891, 114 (418). *Nomen nudum.* Australia.

158. *fulgida* Macquart, *Dipt. Exot.*, Suppl. i, 1845, 180. N.S.W. Ranked as a synonym of *regalis* Guérin by Engel in 1925.

159. *fulvipes* Guérin, *Rev. Zool.*, vi, 1843, 273. Synonym of *Amphibolia speciosa* Erichson by Engel, which appears correct.

160. *fulviventris* Bigot, *Ann. Soc. ent. France*, ser. 5, iv, 1874, 465 (*Formosia*). Tasmania.

161. *fuscotestacea* Macquart, *Dipt. Exot.*, Suppl. i, 1845, 178. N.S.W.

162. *idesa* Walker, *List Dipt. Brit. Mus.*, pt. iv, 1849, 858. Australia.

163. *imperialis* Guérin, *Rev. Zool.*, vi, 1843, 265; Engel, *Zool. Jahrb.*, 50, 1925, 364, redescription. Australia.

incomparabilis Brauer and von Bergenstamm, *Musc. Schiz.*, ii, 1891, 114 (418). *Nomen nudum.* Australia.

164. *inornata* Guérin, *Rev. Zool.*, vi, 1843, 268; Engel, *Zool. Jahrb.*, 50, 1925, 369, redescription. Australia.

165. *lepida* Guérin, *Rev. Zool.*, vi, 1843, 268; Engel, *Zool. Jahrb.*, 50, 1925, 373, redescription.

166. *leucosticta* Schiner, *Novara Reise*, Diptera, 1868, 319; Engel, *Zool. Jahrb.*, 50, 1925, 363, redescription. New Zealand, as given by Schiner for this species, is evidently erroneous, as the specimen in the Austrian National Museum is from Australia.

syn. *variegata* Bigot, *Ann. Soc. ent. France*, ser. 5, iv, 1874, 461 (*Formosia*). This synonymy is apparently correct. Australia.

167. *media* Macquart, *Dipt. Exot.*, Suppl. i, 1845, 182. Tasmania.

168. *minor* Macquart, *Dipt. Exot.*, Suppl. i, 1845, 182; Brauer, *Sitz. Akad. Wiss.*, cviii, 1899, 512 (*Senostoma*); Austen, *Ann. Mag. Nat. Hist.*, ser. 7, xix, 1907, 345 (gen. n.); Townsend, *Proc. Biol. Soc. Wash.*, xxviii, 1914, 23 (*Microrutilia*, gen. n.). Tasmania; N.S.W. Townsend did not see this species, and I am unaware of its characteristics so disregard the generic segregation.

syn. *livis* Walker, *List Dipt. Brit. Mus.*, pt. iv, 1849, 882 (*Musca*), *teste* Austen, *l.c.*

169. *nigrithorax* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 190. Oceania?

170. *oblonga* Macquart, *Dipt. Exot.*, Suppl. ii, 1847, 92; Brauer, *Sitz. Akad. Wiss.*, cviii, 1899, 511 (*Senostoma*). Australia.

171. *onoba* Walker, *List Dipt. Brit. Mus.* pt. iv, 1849, 859 (*Rutilia* group, *Dexia*). Australia.

172. *panthea* Walker, *List Dipt. Brit. Mus.*, pt. iv, 1849, 862 (*Rutilia* group, *Dexia*). Western Australia.

173. *pectoralis* Walker, *Proc. Linn. Soc.*, 8, 1865, 114. New Guinea.

174. *pellucens* Macquart, *Dipt. Exot.*, Suppl. i, 1845, 177; Brauer and von Bergenstamm, *Musc. Schiz.*, ii, 1891, 114 (418); Engel, *Zool. Jahrb.*, 50, 1925, 372, redescription. Australia. Schiner's New Zealand record is probably erroneous, and his reference to the species as a synonym of *desvoidyi* undoubtedly is wrong.

175. *potina* Walker, *List Dipt. Brit. Mus.*, pt. iv, 1849, 857 (*Rutilia* group, *Dexia*). Tasmania.

176. *pubicollis* Thomson, *Eugen. Resa*, Diptera, 1868, 530. N.S.W.

177. *punctum* Walker, *Trans. Ent. Soc. Lond.*, n.s., iv, 1857, 205 (*Senostoma?*). N.S.W.

178. *regalis* Guérin, *Voy. Coquille*, Zool., ii (2) (1), 1830?, 295 (*Musca*); Ibid., Pl. 21, fig. 1 (*Rutilia*); Guérin, *Rev. Zool.*, vi, 1843, 265; Engel, *Zool. Jahrb.*, 50, 1925, 370, redescription. Australia.

179. *retusa* Fabricius, *Ent. Syst.*, iv, 1794, 316 (*Musca*); Wiedemann, *Auss. Zweifl.*, ii, 1830, 420 (*Musca*); Walker, *List Dipt. Brit. Mus.*, pt. iv, 1849, 861 (*Rutilia* group, *Dexia*). Australia. There is some doubt as to the generic position of this species.

180. *rubriceps* Macquart, *Dipt. Exot.*, Suppl. ii, 1847, 92. Tasmania.

181. *ruficornis* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 193 (*Diaphania*); Engel, *Zool. Jahrb.*, 50, 1925, 374 (*Senostoma*). Australia; Tasmania.

syn. *flavipes* Brauer and von Bergenstamm, see previous citation. Engel places this as a synonym of *ruficornis*, while Brauer is of the opinion that it may be a synonym of *variegata* Macquart.

ruficornis Bigot, *Ann. Soc. ent. France*, ser. 5, x, 1880, 88. Australia (Homonym).

182. *sabrata* Walker, *List Dipt. Brit. Mus.*, pt. iv, 1849, 855. Australia.

183. *semifulva* Bigot, *Ann. Soc. ent. France*, ser. 5, x, 1880, 89. Australia. This is evidently the same as *ruficornis* Bigot and, if a good species, this name will have to be used for the species.

184. *setosa* Macquart, *Dipt. Exot.*, Suppl. ii, 1847, 94; Suppl. i, 1845, 176 (*testacea* female). Tasmania.

soror Brauer and von Bergenstamm, *Musc. Schiz.*, ii, 1891, 114 (418). *Nomen nudum.* Australia.

185. *spinipectus* Thomson, *Eugen. Resa*, Diptera, 1868, 530. N.S.W.

186. *spinolae* Rondani, *Arch. Zool. Modena*, iii, 1864, 23. Australia.

187. *splendida* Donovan, *Epit. N.H. Ins. New Holland*, etc., Hymen. Dipt., 1798, pl.* (*Musca*); Guérin, *Rev. Zool.*, vi, 1843, 267; Engel, *Zool. Jahrb.*, 50, 1925, 366, redescription. Australia, Tasmania.

syn. *australasiae* Gray (in Griffith), *Animal Kingdom Ins.*, 2, 1832, p. 793.

syn. *decora* Guérin, *Rev. Zool.*, vi, 1843, 266.

188. *subtustomentosa* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 191. Tasm.

189. *uzita* Walker, *List Dipt. Brit. Mus.*, pt. iv, 1849, 860 (*Rutilia* group, *Dexia*). Australia.

190. *variegata* Macquart, *Dipt. Exot.*, Suppl. ii, 1847, 96 (*Senostoma*). Tasm.
191. *velutina* Bigot, *Ann. Soc. ent. France*, ser. 5, iv, 1874, 463 (*Formosia*), Brauer, *Sitz. Akad. Wiss.*, cviii, 1899, 509. Tasmania.
192. *viridinigra* Macquart, *Dipt. Exot.*, Suppl. i, 1845, 179; iv, pt. 2, 1851, 192; Brauer and von Bergenstamm, *Musc. Schiz.*, ii, 1891, 114 (418); Engel, *Zool. Jahrb.*, 50, 1925, 372. Tasmania; N.S.W.
193. *viriditestacea* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 190; Schiner, *Novara Reise*, Diptera, 1868, 318, says it is synonym of *lepida* Guérin.
194. *vittata* Macquart, *Dipt. Exot.*, Suppl. v, 1855, 126. Australia.
195. *vivipara* Fabricius, *Syst. Antl.*, 1805, 309 (*Tachina*); Robineau-Desvoidy, *Essai Myod.*, 1830, 321; Engel, *Zool. Jahrb.*, 50, 1925, 371, places it as a synonym of *desvoidyi*, ignoring the fact that the latter is a subsequent name. Australia, etc.
196. *zabrina* Walker, *List Dipt. Brit. Mus.*, pt. iv, 1849, 863 (*Rutilia* group, *Dexia*). Western Australia.

LXIX. Genus *Semisuturia* Malloch.
197. *australis* Malloch, Proc. Linn. Soc. N.S.W., 52, pt. 3, 1927, 340. Queensland.

Genus *Senostoma* Brauer and von Bergenstamm (= *Rutilia*).

LXX. Genus *Sisyropa* Brauer and von Bergenstamm.
198. *cinerea* Brauer and von Bergenstamm, *Musc. Schiz.*, ii, 1891, 42. Rockhampton, Australia.
199. *lata* Macquart, *Dipt. Exot.*, Suppl. iii, 1847, 207 (*Exorista*); Brauer, *Sitz. Akad. Wiss.*, cvi, 1897, 340. Australia, N.S.W.

LXXI. Genus *Stilbomyia* (*Silbomyia*) Macquart.
200. *costalis* Walker, *Proc. Linn. Soc.*, 5, 1861, 159; Engel, *Zool. Jahrb.*, 50, 1925, 350. Australia.
201. *opulenta* Walker, *l.c.*, 3, 1858, 104. Aru. Is.; Australia?

LXXII. Genus *Strongygaster* Macquart.
202. *normalis* Curran, *Ent. Mitt.*, 16, No. 5, 1927, 355 (*Strongylogaster*). Queensland.
203. *sensua* Curran, *Ent. Mitt.*, 16, No. 5, 1927, 354 (*Strongylogaster*). Queensland.

LXXIII. Genus *Sumpigaster* Macquart.
204. *fasciatus* Macquart, *Dipt. Exot.*, Suppl. v, 1855, 125. Australia.

LXXIV. Genus *Tachina* Meigen. (*N.B.*—The following species may not be referable here).
205. *bura* Walker, *List Dipt. Brit. Mus.*, pt. iv, 1849, 760. Tasmania; Aust.
206. *coras* Walker, *l.c.*, p. 785. Western Australia.
207. *despicienda* Walker, *Trans. Ent. Soc. Lond.*, n.s., v, 1860, 306; Austen, *Ann. Mag. Nat. Hist.*, ser. 7, xix, 1907, 331, says that it evidently belongs in section *Pyrrhosia* B. & B.
208. *hebes* Walker, *Ins. Saund.*, Dipt., 1852, 289. Tasmania.
209. *inusta* Wiedemann, *Ausser. Zweifl. Ins.*, ii, 1830, 306. N.S.W.
210. *olmus* Walker, *List Dipt. Brit. Mus.*, pt. iv, 1849, 775. Australia.
211. *orga* Walker, *l.c.*, p. 752. N.S.W.
212. *remota* Walker, *Ins. Saund.*, Diptera, 1852, 280 (*Tachina*, *Phryno?*). N.S.W.
213. *similis* Walker, *l.c.*, p. 266. N.S.W.
214. *zebina* Walker, *List Dipt. Brit. Mus.*, pt. iv, 1849, 772. India, Ceylon, Burma, Java, Australia. This is a very widely distributed and common species with the following possible synonyms.

syn. *fusciformis* Walker, *l.c.*, p. 1161.—*mutans* Walker, *Proc. Linn. Soc.*, v, 1861, 240 (*Eurygaster*).—*amplicans* Walker, *l.c.*, iv, 1861, 122 (*Nemoraea*).—*australis* Walker, *Ins. Saund.*, Diptera, 1852, 279—*cilipes* Macquart?, *Dipt. Exot.*, ii, pt. 3, 1843, 219.

LXXV. Genus *Tasmaniomyia* Townsend.

215. *viridiventris* Macquart, *Dipt. Exot.*, Suppl. ii, 1847, 84 (*Masicera*); Townsend, *Canad. Ent.*, 48, 1916, 152. Tasmania. Species not seen by the author of the genus. Original recorded locality of second description is Egypt, but very probably an error. The species was considered by Brauer to have been described twice by Macquart (*Sitz. Akad. Wiss.*, cvi, 1897, 336), the second time in Supplement iv, part 2, 1851, 163.

LXXVI. Genus *Teretrophora* Macquart.

216. *fasciata* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 175. Tasmania.

LXXVII. Genus *Thelairia* Robineau-Desvoidy.

217. *australis* Walker, *Ins. Saund.*, Diptera, 1852, 314 (*Dexia*); Austen, *Ann. Mag. Nat. Hist.*, ser. 7, xix, 1907, 343. Australia.

LXXVIII. Genus *Toxocnemis* Macquart.

218. *vittata* Macquart, *Dipt. Exot.*, Suppl. v, 1855, 124. Adelaide, Australia.

LXXIX. Genus *Thrycolyga* Rondani.

219. *flaviceps* Macquart, *Dipt. Exot.*, Suppl. ii, 1847, 83 (*Exorista*); Brauer, *Sitz. Akad. Wiss.*, cvi, 1897, 342 (*Tricholyga*). Tasmania.

LXXX. Genus *Trichostylum* Macquart.

220. *rufipalpis* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 182. East Coast of Australia.

LXXXI. Genus *Tritaxys* Macquart.

221. *heterocera* Macquart, *Dipt. Exot.*, Suppl. i, 1845 (*Gonia*); Suppl. ii, 1847, 82 (*Tritaxys australis*). Tasmania.

LXXXII. Genus *Ugimeigenia* Townsend.

222. *elzneri* Townsend, *Proc. U.S. Nat. Mus.*, 51, 1916, 316. Banks Island.

LXXXIII. Genus *Ugimyia* Rondani.

223. *fulviventris* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 165 (*Masicera*); Brauer and von Bergenstamm, *Musc. Schiz.*, ii, 1891, 98 (402) (*Crossocosmia*).

LXXXIV. Genus *Verreauxia* Robineau-Desvoidy.

224. *auripilis* Robineau-Desvoidy, *Hist. Nat. Dipt.*, i, 1863, 893. Tasmania.

LXXXV. Genus *Winthemia* Robineau-Desvoidy.

225. *trichopareia* Schiner, *Novara Reise*, Diptera, 1868, 327 (*Exorista*); Brauer and von Bergenstamm, *Musc. Schiz.*, ii, 1891, 98 (402) (*Chaetolyga*). Australia.
varipes Robineau-Desvoidy, *Hist. Nat. Dipt.*, i, 1863, 543 (*Phryno*), an ms. species of Macquart's quoted as *Exorista varipes* Mcq.; Brauer and von Bergenstamm, *Musc. Schiz.*, ii, 1891, 98 (402) (*Chaetolyga*), quoted as *Exorista varipes* Mcq. Tasmania.

LXXXVI. Genus *Zita* Curran.

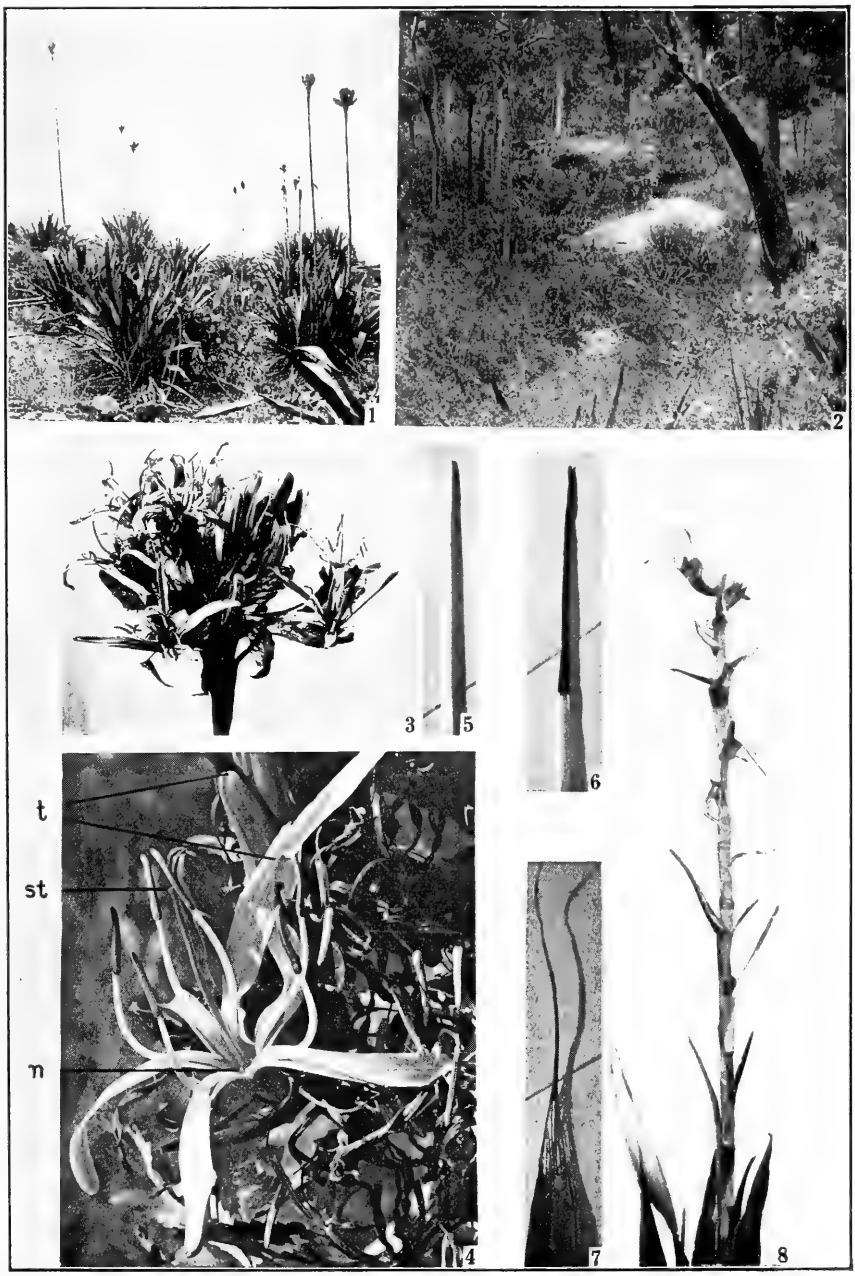
226. *aureopyga* Curran, *Ent. Mitt.*, 16, No. 5, 1927, 351. Queensland.

LXXXVII. Genus *Zosteromyia* Brauer and von Bergenstamm.

227. *cingulata* Macquart, *Dipt. Exot.*, Suppl. iv, pt. 2, 1851, 179 (*Myobia*); Brauer and von Bergenstamm, *Musc. Schiz.*, ii, 1891, 72 (376). East Coast of Australia, Tasmania, Cape York (B. & B.).

LXXXVIII. Genus *Zosteromeigenia* Townsend.

228. *mima* Townsend, *Proc. U.S. Nat. Mus.*, 56, 1919, 579. Queensland.



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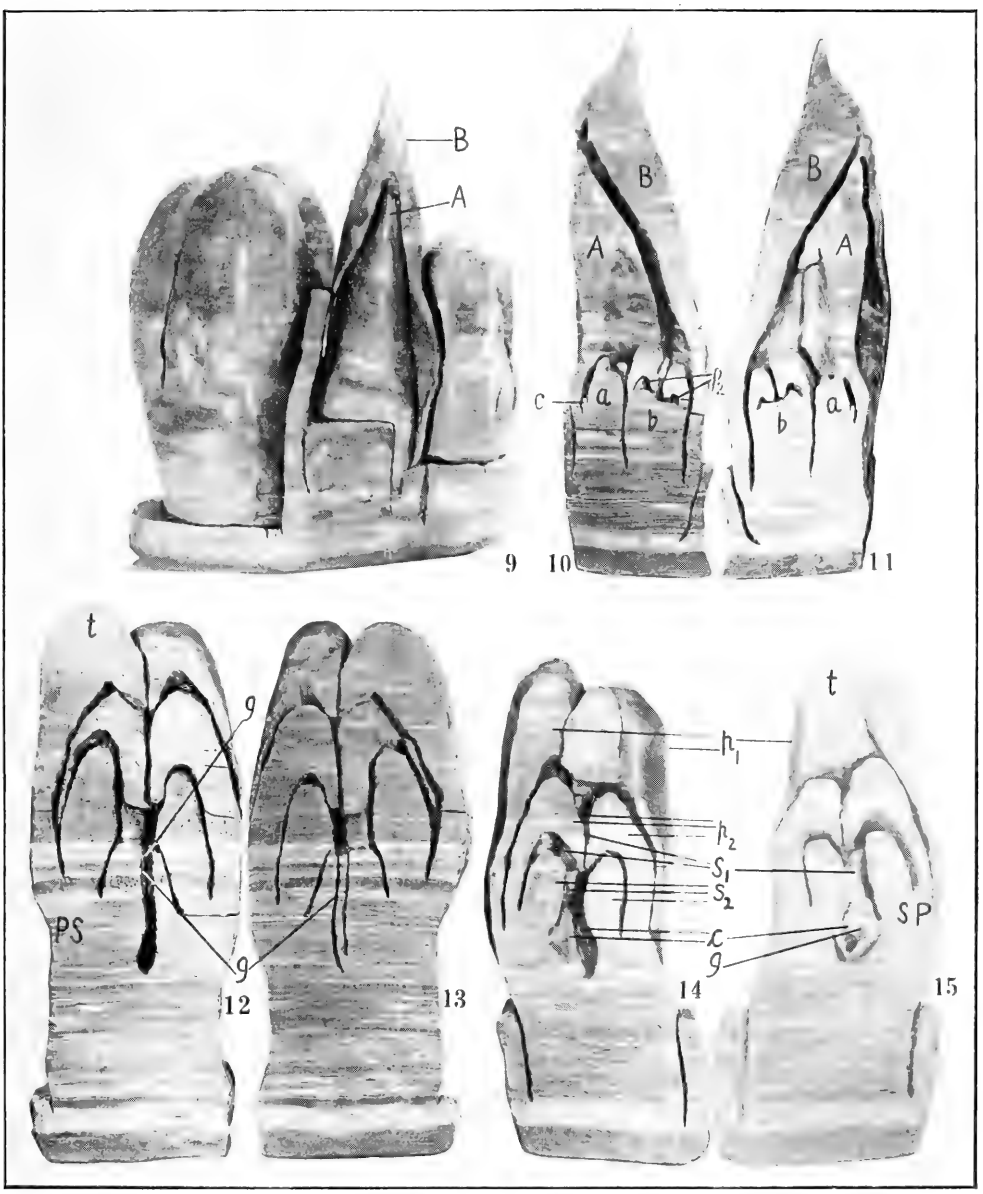
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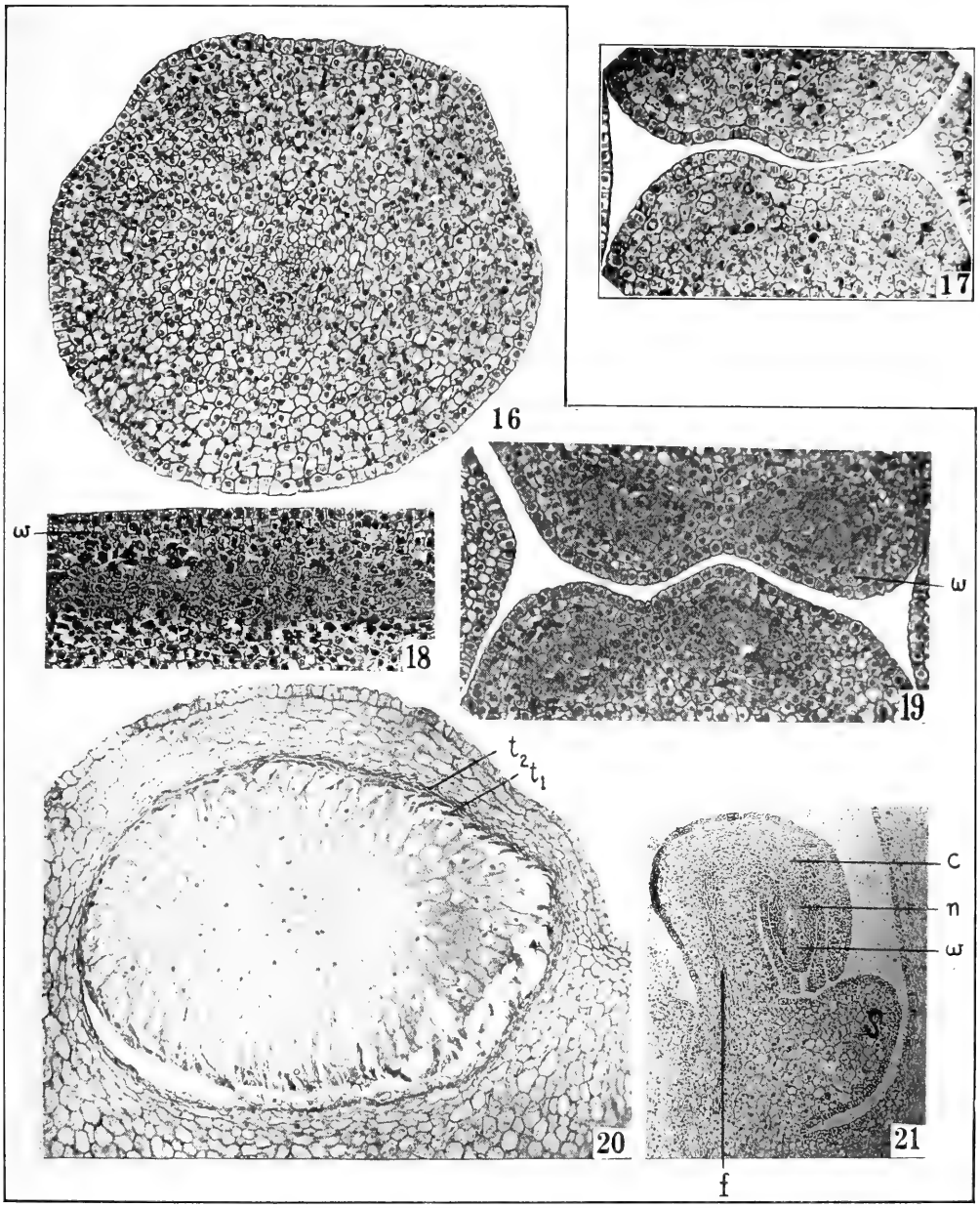
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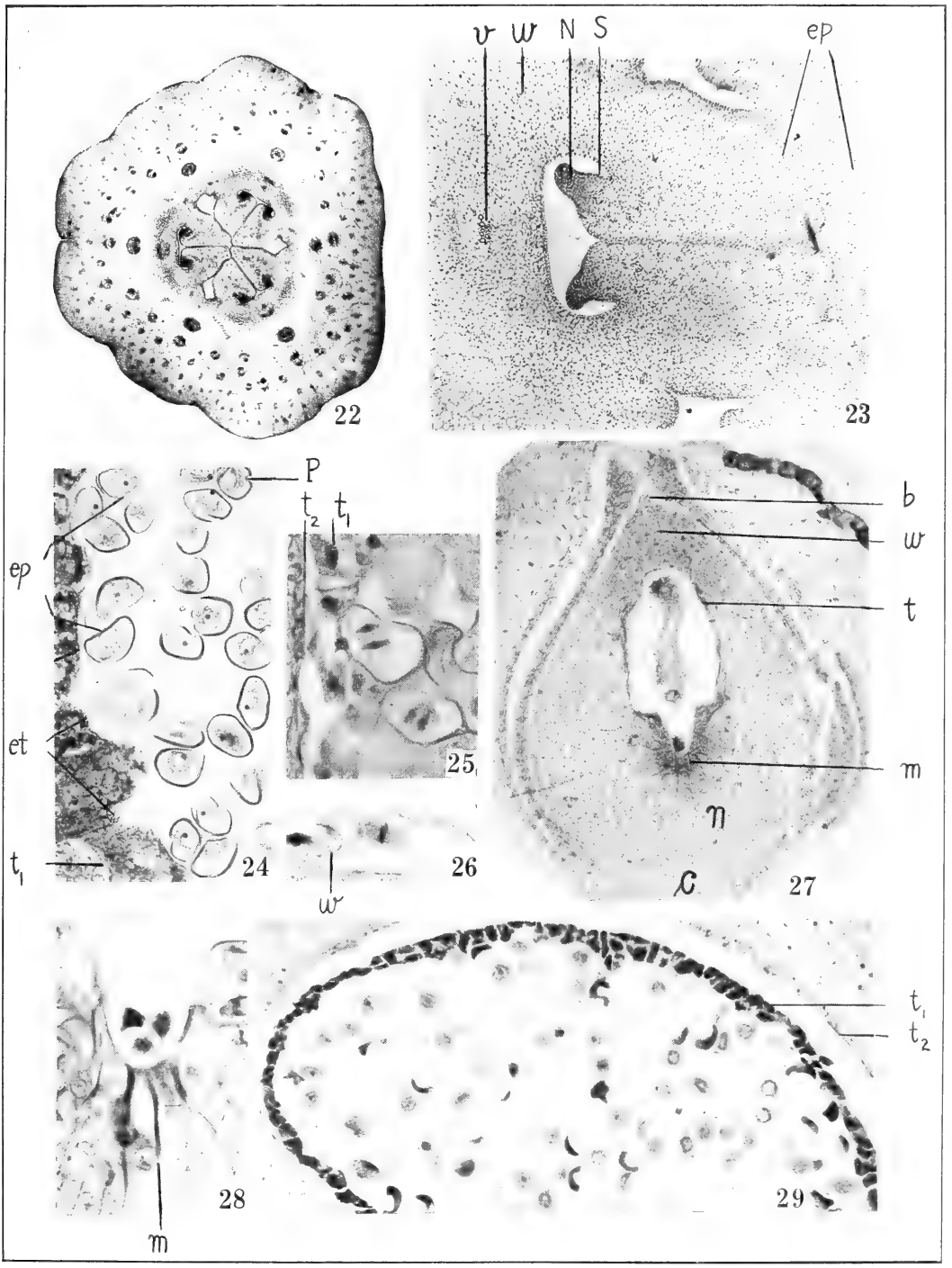
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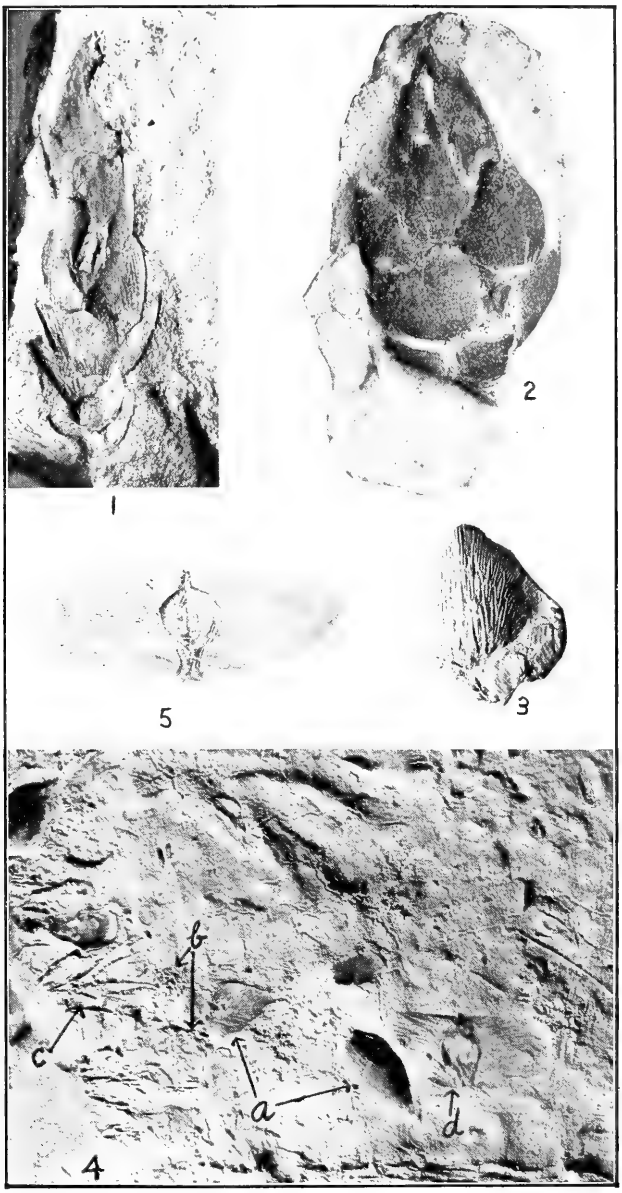
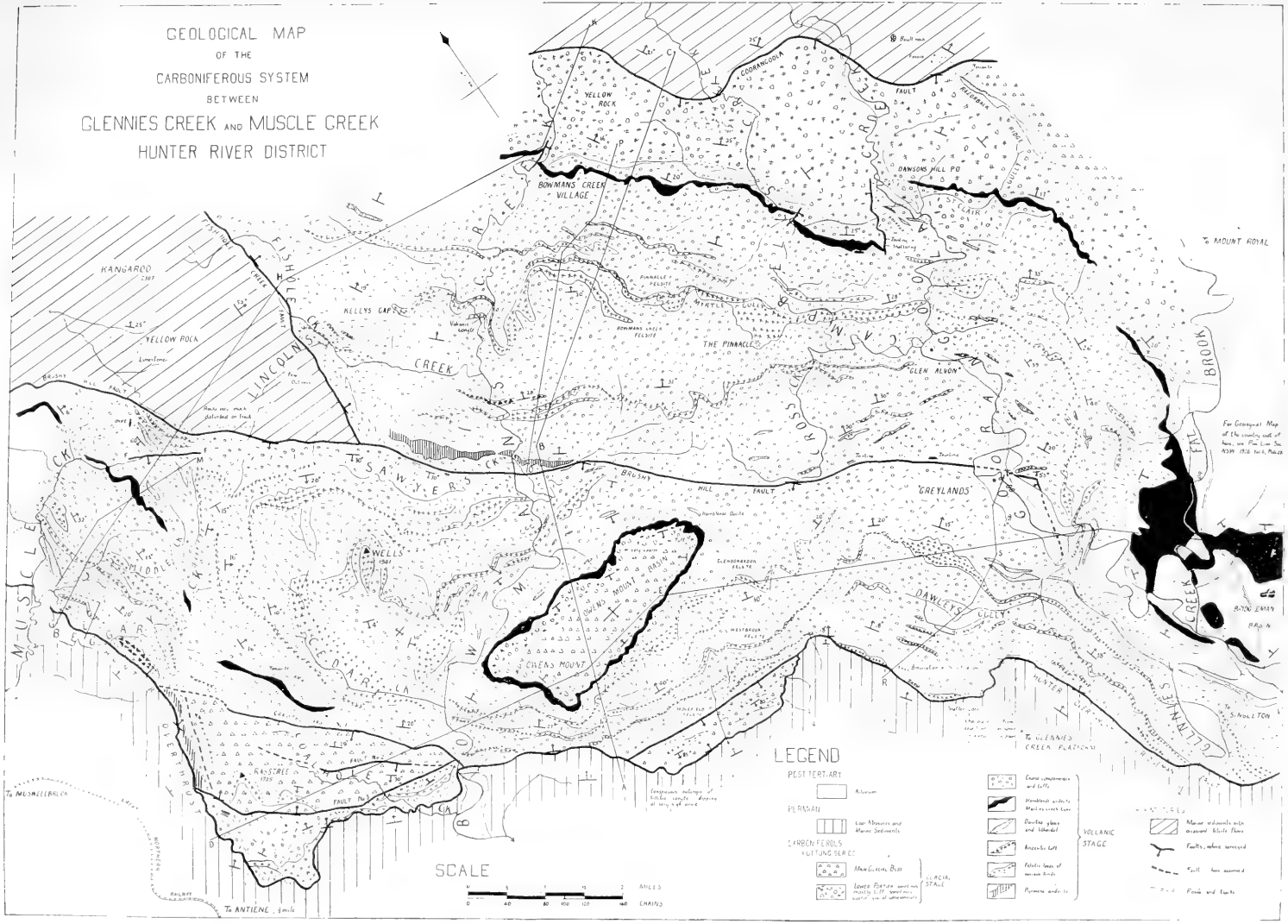
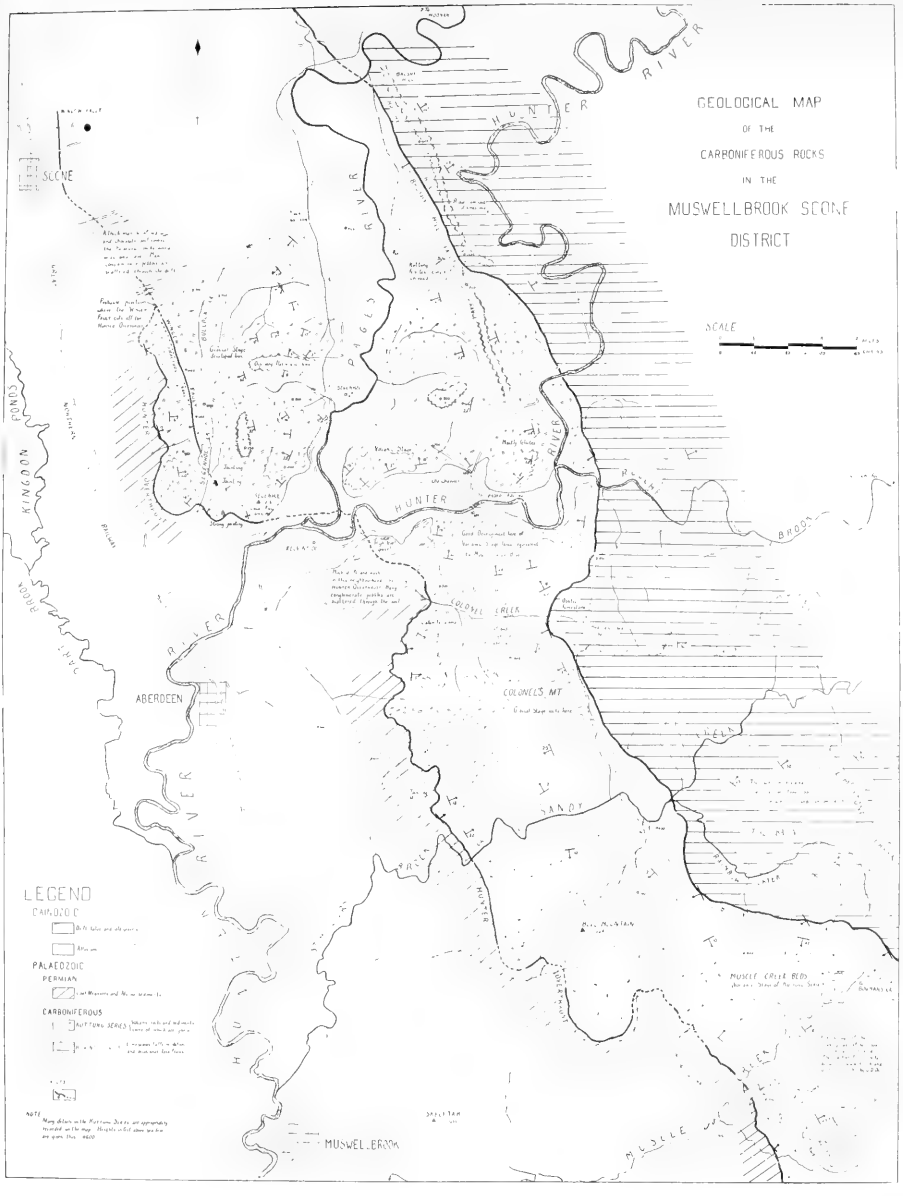
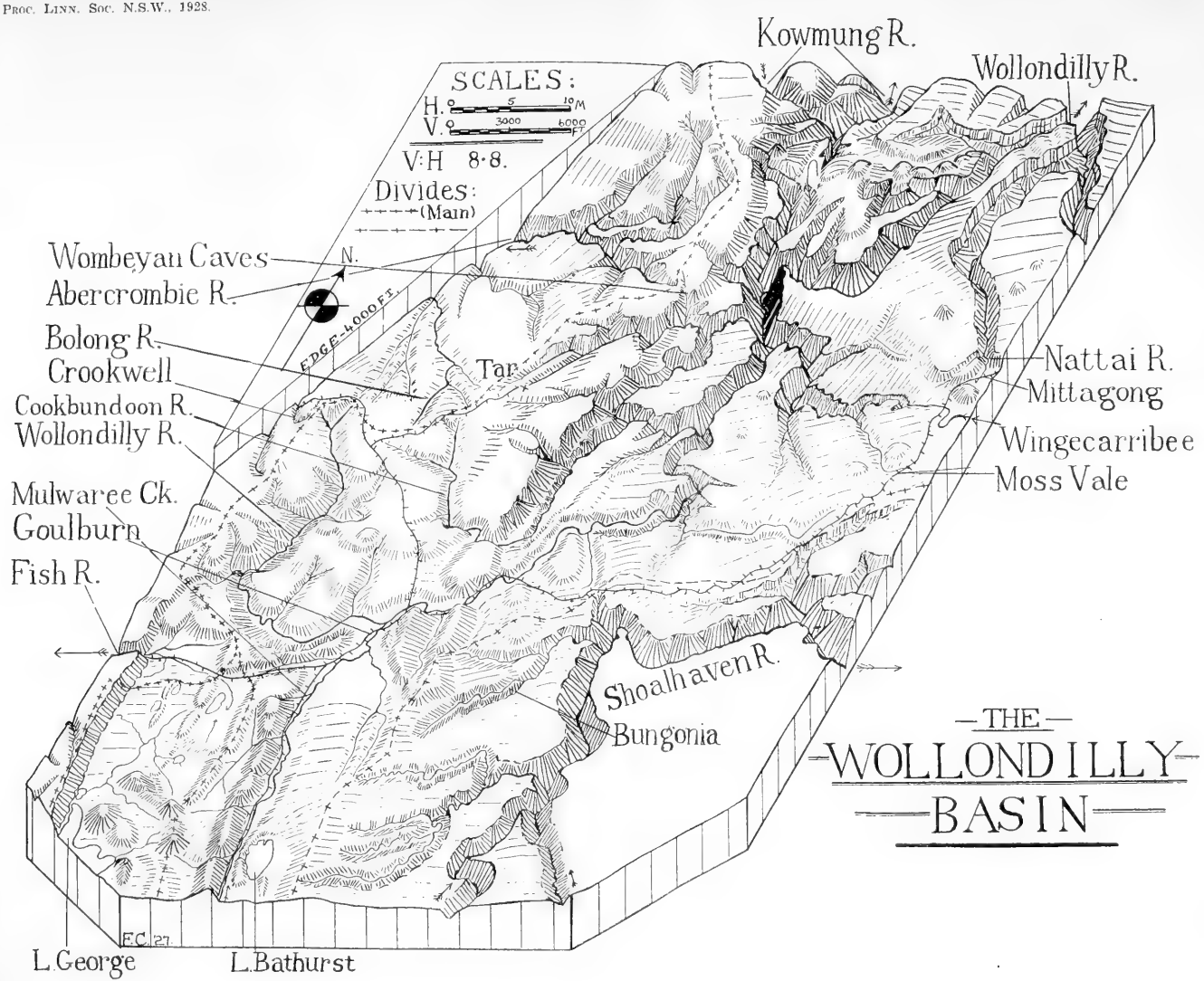


1, 2. Terminal shoots, possibly of *Glossopteris*. 3. "Scale-leaf" of *Glossopteris*. 4. *a*. Scale-leaves of *Glossopteris*. *b*. Groups of "microsporangia" of *Glossopteris*. *c*. Rootlets? *d*. *Samaropsis Pincombei*, n. sp. 5. *Samaropsis Pincombei*, n. sp.


GEOLOGICAL MAP
OF THE
CARBONIFEROUS SYSTEM
BETWEEN
GLENNIES CREEK AND MUSCLE CREEK
HUNTER RIVER DISTRICT
YELLOW ROCK
GOORANGOOLA
FAULT
BOWMANS CREEK VILLAGE
DAWSONS HILL PO
ST CLAIR
To MOUNT ROYAL
KANGAROO
YELLOW ROCK
KELLYS GAP
FISHHOLE CREEK
LINCOLNS CREEK
PINNACLE FELSITE
BOWMANS CREEK FELSITE
THE PINNACLE
GLEN ALVON
CROSS CK
SAWYERS CK
BRUSHY HILL FAULT
GREYLANDS
WELLS
MIDDLE CK
CEDAR CK
OWENS MOUNT BASIN
OWENS MOUNT
DAWLEYS GULLY
HUNTER RIVER
GLENNIES CREEK
BROOKEMAN BASIN
To SINGLETON
To GLENNIES CREEK PLATFORM
MUSCLE CK
BEGGAR CK
OVERTHRUST
RAYSTREE
To MUSWELLBROOK
To ANTIENE
LEGEND
POST TERTIARY
Alluvium
PERMIAN
Coal Measures and Marine Sediments
CARBONIFEROUS
KUTTUNG SERIES
Main Glacial Bed
Lower Portion
GLACIAL STAGE
Coarse conglomerate and tuffs
Hornblende andesite
Marking sheet lava
Dacites glassy and lithoidal
Andesitic tuffs
Felsitic lavas of various kinds
Pyrenean andesite
VOLCANIC STAGE
Marine sediments with occasional felsite flows
Faults, where surveyed
Fault, here assumed
Dome and faults
SCALE
MILES
CHAINS


GEOLOGICAL MAP
OF THE
CARBONIFEROUS ROCKS
IN THE
MUSWELLBROOK SCONE
DISTRICT
SCALE
SCONE
HUNTER RIVER
KINGDON PONDS
ABERDEEN
COLONELS MT
MUSWELLBROOK
LEGEND
CAINOZOIC
PALAEOZOIC
PERMIAN
CARBONIFEROUS
NOTE


Kowmung R.
Wollondilly R.
SCALES:
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V. 0 3000 6000 FT
V:H 8·8.
Divides:
(Main)
Wombeyan Caves
Abercrombie R.
N.
EDGE 4000 Ft.
Bolong R.
Crookwell
Cookbundoon R.
Wollondilly R.
Mulwaree Ck.
Goulburn
Fish R.
Tar
Nattai R.
Mittagong
Wingecarribee
Moss Vale
Shoalhaven R.
Bungonia
THE
WOLLONDILLY
BASIN
E.C. 27
L. George
L. Bathurst

(Issued 16th April, 1928.)

Vol. LIII.
Part 1.

No. 215.

THE

PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES

FOR THE YEAR

1928.

Part I (Pages i-xxxiv)

CONTAINING THE PROCEEDINGS OF THE ANNUAL MEETING.

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LINNEAN MACLEAY FELLOWSHIPS ACCOUNT.

BALANCE SHEET at 31st December, 1927.

LIABILITIES.	£	s.	d.
Amount bequeathed by Sir Wm. Macleay	35,000	0	0
Surplus Income capitalised	10,650	0	0
	£45,650	0	0

ASSETS.	£	s.	d.
Commonwealth Loans	8,540	0	0
N.S.W. Debentures	530	0	0
Loans on Mortgage	36,580	0	0
	£45,650	0	0

INCOME ACCOUNT. Year Ended 31st December, 1927.

	£	s.	d.
To Salaries of Linnean Macleay Fellows	1,069	19	1
„ Fellows' Subsidies	74	3	4
„ Capital A/c	530	0	0
„ General A/c	1,168	16	4
	£2,842	18	9

	£	s.	d.
By Interest	2,842	18	9
	£2,842	18	9

Examined and found correct. Securities produced.

F. H. RAYMENT, F.C.P.A.,
Auditor.

Sydney, 8th February, 1928.

G. A. WATERHOUSE,
Hon. Treasurer.

Sydney, 9th January, 1928.

BACTERIOLOGY ACCOUNT.

BALANCE SHEET at 31st December, 1927.

LIABILITIES.	£	s.	d.	ASSETS.	£	s.	d.	£	s.	d.
Amount bequeathed by Sir Wm. Macleay	12,000	0	0	Commonwealth Loans				14,800	0	0
Accumulated Income capitalised	2,000	0	0	Cash: Commercial Banking Company	266	4	1			
Income A/c at 31st December, 1927	1,194	16	6	Government Savings Bank	128	12	5			
								394	16	6
	£15,194	16	6					£15,194	16	6

INCOME ACCOUNT. Year Ended 31st December, 1927.

	£	s.	d.		£	s.	d.
To Salaries and Wages	503	6	8	By Balance from 1926	1,039	12	4
„ Expenses	88	5	2	„ Interest	752	16	0
„ Petty Cash	6	0	0				
„ Balance to 1928	1,194	16	6				
	£1,792	8	4		£1,792	8	4

Examined and found correct. Securities produced.

F. H. RAYMENT, F.C.P.A.,

Sydney, 8th February, 1928. Auditor.

G. A. WATERHOUSE,

Hon. Treasurer.

Sydney, 9th January, 1928.

(Issued 15th May, 1928.)

Vol. LIII.
Part 2.

No. 216.

THE

PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES

FOR THE YEAR

1928.

Part II (Pages 1-150.)

CONTAINING PAPERS READ IN MARCH-APRIL.

With fourteen plates.

[Plates i-xiv.]

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(Issued 16th July, 1928.)

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Page 14, line 22, for *Tyramorphus*, read *Tyromorphus*
Page 35, line 39, for *australe*, read *australis*
Page 101, line 40, for *sinuatifscia*, read *sinuatifascia*

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OF THE

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OF

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FOR THE YEAR

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